The CHEMIST

Publication of

THE AMERICAN INSTITUTE OF CHEMISTS, INC.

EDWARD L. GORDY, *Editor*, 233 Broadway, New York City

VOLUME IX MARCH, 1932 NUMBER 3

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Entered as second-class matter February 28, 1930, at the Post Office at Easton, Pa., under act of August 24, 1912.

Issued monthly at 20th and Northampton Sts., Easton, Pa.
Subscription price, $2.00 a year. Single copy, 25 cents.

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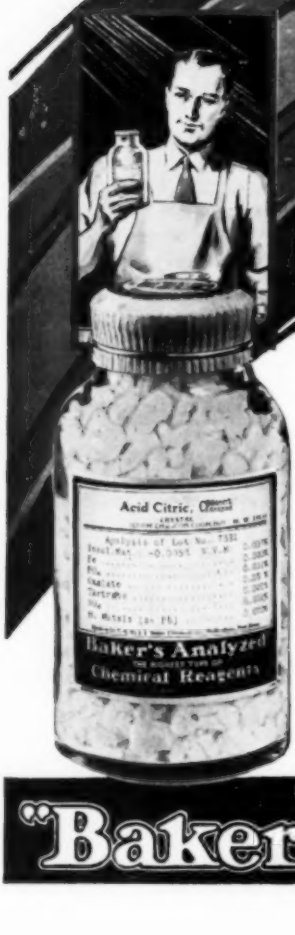

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EDITORIALS

A Suggested Plan

THE recent mass meeting of the chemical profession has led to a great deal of thinking about chemical unemployment. Our own thoughts have taken the form of a plan—a plan which is highly tentative and subject to criticism and improvement. Perhaps it is completely impossible. We shall present it, however, for what it is worth.

In times of unemployment workers who normally would be adding to the wealth of the world are withdrawn from productive enterprises and must be supported, directly or indirectly, by the efforts of others. Much of this unemployment is technological and must be taken care of by complete economic readjustment. Coal miners and certain other classes of workers must await the slow industrial drift which will take them out of an overcrowded occupation.

Many occupations need an elaborate system of planning. Many workers are simply cogs in a machine which it is no longer profitable to run. A structural steel worker is helpless in times of depression. He can be employed on public works (if the government deficit has not mounted to the point where public works are impossible); but the public buildings erected by his efforts are not a commercial product. He must be paid by some sort of tax upon the entire country.

Some of the professions are in much the same situation. When industrial enterprises fall below the normal level of activity, the lawyer, whose task is expediting business and human relationships, finds himself unable to use his interpretative skill. The work of the criminal lawyer may increase, as may that of the patent lawyer; but other lawyers find that a depression means reduction in the need for their services—and consequent almost complete removal of their ability to produce goods.

The chemist, however, is in an entirely different category from any of these. His wealth-creating potentialities are principally within himself, and require no immensely elaborate equipment with which to work. With a small investment he can go about his chosen task of increasing the world's wealth.

Unfortunately, the individual chemist is in most cases not in a position to be himself the *entrepreneur* in exploiting his wealth-producing capa-

bilities. When unemployed, he devotes his efforts to looking for a job rather than to starting a piece of research. The more desperate he becomes, the less likely he is to take time for his own chemical enterprises. In many cases also, he is incapable of thinking out projects for himself. The chemical profession, like every other profession, has men who are simply expert technicians, efficient in following leaders.

In any case, the risk of a new enterprise should not fall upon the individual chemist. Usually he does not succeed in acquiring for himself the benefits even if he is successful.

WE ARE faced, then, with a situation in which a large number of potentially valuable men are in a state of stagnation. They add nothing to the world, and they prolong the depression by using up the economic goods which have already been created.

Is it possible to devise a scheme which will make these men producers? Can we restore their buying power by enabling them to create wealth? Such a scheme certainly ought to be possible.

Our idea is, briefly, the creation of a foundation or endowment whose income shall be used as an elastic fund to take up the sags of unemployment in the chemical profession. It is true that there are already in existence a number of research institutes. Moreover, money used for this new purpose would be withdrawn from other production-inciting enterprises; but comparative benefit to mankind ought to be the criterion which determines the direction in which pools of wealth-producing capital are allocated. And this fund would differ from other foundations in that it would be not a gift to the world but an investment.

Let us examine the mechanism of such an endowment's operation. There are, let us assume, a thousand qualified, competent, unemployed chemists in the metropolitan area. If these men could be put into laboratories and paid a certain minimum wage, with the additional proviso that they be given a part of the proceeds arising from such chemical wealth as they produce (processes, patents, improvements on present chemical operations), they might well succeed in making the fund pay for itself.

If chemists are benefiting mankind at all, the success of such a foundation is inherent in the conditions. If the unemployed men lack ability as chemists, there is nothing to be said in their favor as regards assistance in following their profession. In times of general depression, however, there are many able men without gainful employment. If they are unable to produce sufficient wealth to support their own activities, the chemical profession is not justifying its existence.

Granting the ability, these men would certainly have the incentive to produce—a factor which has been lacking in certain other research institutes, and the absence of which has been chiefly responsible for the small productivity of such institutes. Interest in scholarship alone is not sufficient to keep the average man, even the average scientist, working to the full (or even to a reasonably full) degree of his productive ability. Security in scholarship has resulted in scholarly indolence. The satisfaction of having contributed to scientific knowledge seems to have a rapidly decreasing marginal return. In plain words, the output of certain research institutes has not been proportionate to the capital wealth expended. A new institute is proposed in which material incentive is added to the lure held before the scientist.

The amount of money required would be enormous, but no more than was required for other institutes; and it is rapidly becoming apparent that the world's capital ought to be used for economic planning, rather than for advancing pure science by methods of questionable efficiency.

A fund of magnitude comparable with other foundations could be established—an endowment, let us say arbitrarily, of fifty million dollars. The income from this endowment would be used to pay qualified, unemployed chemists a salary definitely below what they would receive in industry. There are many industrial chemical problems awaiting solution. Unemployed chemists, under competent direction and preferably working in their own particular fields, would do research on these problems. Successful solution would be followed by patenting the process and by its sale to industry or its development as a commercial process by the chemists of the foundation itself. In either case, there would be financial return to the foundation and to the chemists responsible. The world would benefit, and so would the chemical workers.

Financial return to the discoverers seems necessary for the adoption of scientific advances. The Rockefeller Institute has found that the world hesitates to adopt scientific discoveries which are gifts. Companies will not spend money for equipment on too altruistic a basis. When scientific knowledge becomes as free as air, the utilization of it becomes as commercially risky as the utilization of atmospheric nitrogen for fertilizers.

UNDER the proposed foundation, the chemists would work as far as possible in laboratories already in existence—university laboratories now idle, industrial laboratories which could be rented, and other temporary quarters. The building of a special laboratory would defeat

the foundation's purpose of taking up the sags of industry; for a necessary condition of the plan must be that in periods of prosperity chemists would prefer to work in established industry rather than at the minimum wage paid by the foundation. Any other scheme would have simply the effect of increasing the number of chemists. If chemists were employed by the new foundation in times of normal industrial activity, the whole process would have to be instituted anew at the time of the next depression.

The foundation, or institute, then, would work on the practical problems of industry in the manner of the Mellon Institute. Its proceeds would go toward its own perpetuation and to reward the chemists employed.

It seems fairly certain that a body of capable chemists, working with an incentive to produce marketable chemical discoveries, can produce them. A successful system is now in operation at Columbia University, with patent arrangements and proportionate rewards as devised by Mr. Howard S. Neiman; and a foundation established to give unemployed chemists the same opportunity ought eventually to pay for itself.

Such an institute would take care of unemployed chemists and would remove from employed chemists the fear of being thrown into a state of poverty by a depression.

There would be in addition an indirect beneficial effect upon industry. Any company, feeling that a discharged chemist would work on processes which might render their own patents obsolete, would hesitate to dispense with competent men. Companies would utilize for their own gain the wealth-producing capacities of their scientists.

THIS is a tentative plan, which probably has flaws and which would need to be worked out in a great deal more detail. Some scheme would have to be devised to keep the hypothetical research institute from attracting into chemistry a large number of young college graduates, who would constitute a greater accretion to the profession than industry could absorb even in normal times. Requirements would have to be laid down as to the ability of the chemists employed. Care would have to be taken that the foundation did not become an asylum for the incompetent and the indolent, who ought to be eliminated from the profession. Ease of return of chemists to industry would have to be provided; and it would have to be definitely specified that excess income, in times of prosperity and lack of technical unemployment, would be turned to other productive enterprises of man.

Some endowment of this sort ought to be possible of development.

Foundations without its advantages and with inherent defects have been set up. We should like to see a sensible arrangement in which an endowed or perhaps government-supported institute took advantage of the psychological factors which make mankind a happy producing machine.

Perhaps by the time this is in print some solution of the problem will have been devised. Thus far, in spite of the mass meeting, we have seen nothing on the horizon which is even remotely a logical permanent solution of the recurring cycles of unemployment in the chemical profession.

Present Emergency

WHATEVER is finally done to level out the curves of chemical unemployment, immediate steps need to be taken to meet an existing critical situation. As those who attended the mass meeting discovered, some chemists and chemical engineers are in actual want.

The resolutions reported on page 243 of this issue of *The* CHEMIST do not state the situation any too strongly; and *The* CHEMIST is therefore glad to report the following resolutions of the National Council of the American Institute of Chemists, adopted at a meeting on March 10th:

Resolved, that The American Institute of Chemists accept the submitted Resolution of the Volunteer Workers' Committee for the organization of a central committee to forward the work of the Volunteer Workers' Committee, and that Dr. Frank G. Breyer and Mr. W. J. Baëza be hereby appointed as representatives of The American Institute of Chemists to such central committee.

Resolved, that The American Institute of Chemists hereby appropriate the sum of five hundred dollars through its New York Chapter for said central committee, subject to the call of that committee.

The Influence of Business Risks on the Chemical Industry

By D. P. Morgan, Jr.

A chemical economist lists some of the factors that govern the development of chemical enterprises. The tests industry and company must meet to be commercially successful.

AT FIRST glance almost any one of the larger chemical companies presents a picture of such complexity that a rational analysis seems impossible. Thus, one company will derive its profits from such widely diverse products as heavy chemicals, explosives, lacquers, rayon, tetraethyl lead, synthetic ammonia, and cellophane; another depends on such apparently unrelated products as dyes, alkalies, coal-tar products, heavy chemicals, and synthetic ammonia; a third gets its income from compressed oxygen and acetylene, carbide, ferro-alloys, carbon products, graphite, and synthetic organic chemicals.

The present discussion cannot provide a satisfactory answer to the question of why such complicated groupings have occurred. However, it is interesting to consider this problem in the light of the various economic factors which have influenced the growth and development of business enterprises that are not quite so complex.

For this purpose a list of representative economic factors has been compiled. As the list is a long one, it has been divided into several different headings. Most business tests pertain to one of the following classifications:

I. Raw materials
II. Goods in process and finished goods
III. Plant operations

IV. Management
V. Earnings
VI. Financial position.

In several cases a further subdivision of the factors has been convenient. This has occurred, for example, where some of the economic factors affect the industry as a whole rather than individual companies.

We shall first consider a number of economic factors which are generally to be considered in investigating the raw material situation of any particular industry or company engaged in that industry. Obviously there have been omitted many factors which would have to be considered by an organization planning to enter a particular field. We shall confine ourselves throughout to a consideration of factors of such great importance that the success or failure of an enterprise is determined thereby.

I. Tests Concerning Raw Materials

Industry	Company
1. Proportionate cost	8. Vertical integration
2. Price fluctuation	9. Reserves
3. Inventory problems	10. Ratio to supply
4. Seasonal supply	11. Relations with producers
5. Uncertain supply	12. Plant location
6. Foreign source	
7. Single source	

1. **Proportionate Cost.**—The expression "proportionate cost" is intended to bring out the significance of raw material costs to the total cost. For example, in the case of a pharmaceutical such as Lambert's Listerine the proportionate cost of the raw materials is so small as to be of virtually negligible importance in the economics of this company's business; whereas, in the case of such basic chemical commodities as soda ash and sulfuric acid, raw material cost is a significant item. In this latter case there is, therefore, an element of potential risk from the point of view of raw material cost.

In the case of soda ash the principal raw materials from the point of view of cost are limestone, coal, coke, sodium chloride brine, and ammonia. The business advantage to be obtained by owning one's own brine and limestone reserves is so obvious that it may be taken for granted that all the soda ash manufacturers will have taken steps to

acquire control of their own sources of these raw materials. Their requirements of coke, coal, and ammonia represent a small portion of the country's total production of these materials and are therefore readily purchased in the open market without undue risk of untoward price developments. Under a subsequent heading called "Location of Plant" there will be a further discussion of risks or advantages which may occur to individual companies in this industry through the location of their plant with respect to these particular raw materials.

In the case of sulfuric acid the principal raw material is sulfur or sulfur dioxide, depending upon the practice followed. Only a few companies are so located as to be able to use sulfur dioxide. Here again the feature of plant location is involved. But, from the point of view of the industry as a whole, by far the largest part of sulfuric acid produced in this country is made from elementary sulfur, and this sulfur is obtained from Texas.

As the output of sulfur is dominated by two companies, it is clear that for many producers of sulfuric acid there is a distinct element of risk in the cost of their raw material. While theoretically the sulfur companies could increase the price, in actual practice competition from the marginal competitor, Spanish pyrites, places a top limit on sulfur. The disadvantageous position of the sulfuric acid producer is only acutely evident therefore in times of depression, when great pressure is brought to bear on the price of sulfuric acid and the price of sulfur does not yield in a corresponding manner.

After a consideration of this situation it is not surprising to hear that at least one large sulfuric acid manufacturer is an important stockholder of one of the two sulfur producing companies in Texas. Another large manufacturer of sulfuric acid, the American Cyanamid Company, has been making strenuous efforts to enter the sulfur business on its own account.

There will be a further discussion of the sulfur dioxide and pyrites situations under the heading "Plant Location."

2. **Price Fluctuation.**—One of the best examples of raw material price fluctuation has occurred in the last year or two in the alcohol industry. In this industry molasses is used as a raw material, and its cost represents a significant proportion of total cost. In this particular instance the price of the raw material has varied over 100%.

As yet no very successful method of combating this evil has been worked out, but there is no doubt that this is the reason why the U. S. Industrial Alcohol Company is found to have subsidiaries such as the Porto Rican Mercantile Company and Dominican Molasses, etc., which

AMERICAN ENKA RAYON PLANT

are engaged in the operations of collecting, storing, and shipping molasses for the parent company.

Another good example of this type of situation has occurred in the case of the Commercial Solvents Company, which formerly depended entirely on corn as a raw material for the fermentative manufacture of butanol. As corn prices were found to vary over a very wide range, the Commercial Solvents Company devoted considerable attention to developing the use of rye as a raw material. Recently, corn prices declined sharply, but the price of rye declined even more markedly; and the company derived a very satisfactory saving as a result of their foresight and the effectiveness of their research.

3. Inventory Problems.—Naturally, as the alcohol companies have to carry large stocks of molasses, they are faced with serious inventory problems resulting from the variation in the price of their raw material molasses. Thus, the U. S. Industrial Alcohol Company was forced to take a $3,000,000 inventory loss in 1930 as a result of a decline in the price of molasses.

An unusual instance of the effect of an inventory problem upon the development of a chemical company occurred in the case of the du Pont Company, which was left at the close of the War with large inventories of nitrocellulose. Their solution of this problem resulted in the creation of their extremely profitable Duco division, which uses this type of material as a raw material in the manufacture of lacquers.

4. Seasonal Supply.—The alcohol industry also offers a good instance of the seasonal nature of the raw material. The molasses is virtually all produced when the sugar cane is harvested and processed during the last few months of the calendar year; and one of the uncertainties in the alcohol business has been the necessity of estimating at that time how much molasses to buy for the succeeding year. A natural consequence of this economic situation has been a trend favoring the survival of the larger and more strongly financed companies, which are better able to maintain an adequate cash position to cope with this situation.

5. Uncertain Supply.—This heading could cover a large number of situations, but in the present instance it is intended to apply in particular to uncertainties in supply which may arise from the exhaustion of natural resources. For illustration, take the case of the Texan sulfur companies, both of which are forced to expend considerable sums annually in exploration of new deposits of sulfur.

In both instances large contracts have been signed with oil producer companies which had the good fortune to discover sulfur on their properties. Again, in the case of Freeport, Texas, the uncertainty of their reserves of sulfur has resulted in an effort to reduce over-all business risk by increasing diversification. This was accomplished by using their adequate cash for the purpose of entering another industry, the production of manganese, through their recently acquired controlling interest in the Cuban American Manganese Corporation.

6. Foreign Sources.—As an example of the economic problems introduced by this factor, reference may be made to the case of the Union Carbide & Carbon Corporation. An important product manufactured by this company is ferrochrome, which is made mainly from chrome ore imported from Rhodesia, in southern Africa. The element of risk involved in dealing with foreign corporations has led the Union Carbide Corporation to take steps toward obtaining better control of this situation.

7. Single Source.—It occasionally happens that a company finds itself in a position where it depends almost entirely upon one other company as a producer of an important raw material. A good example of this type of situation has already been described in connection with the manufacture of tetraethyl lead, where the du Pont Company depended almost entirely on Roessler & Hasslacher for its supply of metallic sodium. For this reason and for other reasons, the du Pont Company reduced the risk by absorbing Roessler & Hasslacher.

8. Vertical Integration.—A very frequent economic cause for the

ECONOMIC CONDITIONS CAUSED THE FAILURE OF THIS PLANT. LARGEST U. S. PLANT FOR LOW TEMPERATURE COAL CARBONIZATION

merging of chemical companies has been the possible advantage to be derived from vertical integration. A good example of this type of development is found in the Allied Chemical & Dye Corporation, where one excellent reason for undertaking the manufacture of nitrogenous fertilizer was the fact that a favorable outlet for soda ash manufactured by the parent company's Solvay division was provided thereby. In a similar way du Pont's decision to enter the synthetic nitrogen field was undoubtedly influenced by the fact that their large requirements of nitric acid in the manufacture of explosives, dyes, etc., would offer an important outlet for a significant part of the ammonia production.

Another instance in which the tail has possibly come to wag the dog concerns the Union Carbide Company. It is understood that the calcium carbide division of this company was originally interested in the oxyacetylene field purely as an outlet for acetylene. Accordingly, the production of oxygen was undertaken as a necessary concomitant. It was not long, however, before the business in oxygen became at least as important, if not more important, than the business in carbide.

Other cases will be considered under the head "By-products."

9. Reserves.—From the point of view of any individual company which extracts its own raw material from natural sources, the inadequacy of reserves is often a reason for acquisition of new properties. An ex-

ample of this occurred in the case of the acquisition of the Amalgamated Phosphate Company by American Cyanamid Company. The latter company is a big consumer of phosphates and expected to take a large proportion of the output of its newly acquired subsidiary.

10. Ratio to Total Supply.—It is clear that as regards the business risk involved, the extent of the company's consuming power in proportion to the total available supply of the particular raw material is significant. Thus, if the company is sufficiently large to take half the country's output of this raw material, a very definite degree of risk is involved. A good example of this type of situation formerly existed in the solvents industry, where the du Pont Company, through its Duco lacquer division, was a predominant consumer of butanol. As a result, however, the du Pont Company has developed a process for manufacturing a closely related substitute, which greatly decreases the dependency on Commercial Solvents, the principal producer. The effect of such a development on du Pont's trading position is obvious.

The du Pont Company is such a large factor in the chemical industry that it is not surprising to find it involved in other instances of this same type of situation. For example, in the manufacture of celluloid large quantities of camphor are consumed; and the du Pont Company was such a disproportionately large consumer of this product that they spent considerable time and money in developing a synthetic process for the manufacture of this material. In this way they hoped to improve their trading position with reference to the Japanese producers.

Again, when the manufacture of tetraethyl lead progressed with such rapid strides, the degree of dependence of the du Pont organization upon the Dow Chemical Company as a source for $EtBr_2$ became a cause for worry. Consequently, it was not long before the widely heralded "bromine ship" enterprise occurred, in which the du Ponts demonstrated that they could manufacture their own bromine if forced to do it.

11. Relations with Producers.—In this category are included only those relations which are not exactly typical of ordinary business dealings. To illustrate this point, the operations of the Barrett Company, subsidiary of Allied Chemical & Dye Corporation, will serve. The Barrett Company is a large consumer of coal tar, which is obtained from by-product oven operations. A joint product with the tar is ammonium sulfate; and in order to strengthen relations with the by-product manufacturers the Barrett Company distributes this sulfate for them. Again, in the case of the sulfate, sulfuric acid is required,

and this offers an outlet for the product of the General Chemical Company, another subsidiary of Allied Chemical & Dye Corporation.

A further extension of relations between producer and consumer involves actual stock holdings. A good example of this type of relationship occurs in the glass industry, where a group of glass companies are majority stockholders in an alkali company from whom they obtain their soda ash. Such a relationship exists between the Diamond Alkali Company and the Atlas Glass, C. L. Flaccus Glass, and the MacBeth-Evans Glass companies.

12. Location of Plant.—Probably one of the best examples of a company whose growth and development has been controlled to a marked degree by the location of its plant is the Dow Chemical Company. Practically all the operations in this company are based on the utilization of the peculiar brines which occur in northern Michigan. These brines contain chlorides, bromides, magnesium, calcium, etc., and the complicated operations of the Dow Company are delicately balanced according to the proportions in which these different components occur. As far as manufacture of other products is concerned, this plant is not favorably located.

Other instances of plant locations determined by availability of raw materials occur in the cases of the alcohol manufacturers who depend on molasses as a raw material and who are consequently located on the Gulf or on the Atlantic seaboard. Most of the molasses comes by ship from Cuba.

The Commercial Solvents Company is also necessarily located in the heart of the corn belt; the electrolytic caustic manufacturers are near cheap power; and the Solvay alkali companies are generally close to adequate supplies of limestone and brine.

In the case of the Solvay Company at Syracuse, however, while the original plant was adequately supplied with convenient reserves of these materials, the enormous growth of the business has resulted in expansion of plant facilities to an extent necessitating the acquisition of more remote sources of raw material.

As regards fuel, which is a costly item in alkali manufacture, most available plant sites are fortunately within a reasonable distance of the main producing centers. An interesting current development in the alkali industry concerns the projected plant of the American Cyanamid Company and the Pittsburgh Plate Glass Company, which is to be located in Texas. It is said that this company will have adequate supplies of salt, limestone, and fuel very near at hand—though the question

whether they are as advantageously located with respect to markets has been raised.

II. Economic Tests Pertaining to Finished Goods and Goods in Process

Industry

13. Proportionate cost
14. Price fluctuations
15. Inventory problems
16. Seasonal demand
17. Dependence on prosperity
18. Replacement demand
19. Elastic market
20. Commodity competition
21. Government interference
22. Foreign competition
23. Trade practices
24. Growth

Company

25. Special cost advantages
26. Location
27. Relations to customers
28. Relations to subsidiaries
29. Relations to competitors
30. Contracts
31. Good will and advertising
32. Returns and rejects
33. Monopoly
34. Diversity of outlets
35. Full line

13. Proportionate Cost.—In many chemical industries the manufacturing cost is a very large proportion of the total cost of the product. In other cases, however, it happens that administration and selling expenses are heavy and that manufacturing costs are a less important item. Where this is the case, it naturally follows that success comes to the more efficiently managed companies, which will grow horizontally, either by the expansion of their own facilities or by absorption of smaller units. In this way the proportionate charge for overhead per unit of output is decreased.

It would seem that this type of economic factor has had an important effect on the growth and development of the soap and pharmaceutical industries. In each of these industries there are numerous small companies, but by far the largest part of the business is done by a handful of very large organizations, whose products have national distribution.

14. Price Fluctuations.—In the case of price fluctuation of finished goods the alcohol industry will serve again as an excellent example. In the past few years the price of alcohol has varied over a range of more than 100% with the result that the industry is highly speculative. An interesting outcome of this situation has been the wide-spread effort on the part of the alcohol companies to decrease their business risk by

extending their operations to the manufacture of alcohol derivatives and other solvents.

15. Inventory Problems.—Inasmuch as a very large proportion of chemical commodities are not stocked but are produced on large orders for big manufacturers, it follows that in general the chemical industry is not seriously vulnerable to inventory write-offs with respect to finished goods or goods in process.

During the recent decline in rayon prices, however, there is little doubt that some of the principal manufacturers were forced to take losses on their inventory of finished goods of this material. This brings up an interesting point, namely, that big companies, such as the du Pont Company, which are interested in many other different enterprises, are able to face the risk of loss from this type of situation more effectively than smaller companies which are interested in the one industry only. On the other hand, the smaller company, if efficiently run, can often gain a considerable advantage in a price war, through greater mobility.

COKE-QUENCHING PLANT

16. Seasonal Demand.—A good example of seasonal demand is found in the fertilizer industry, where the farmer does practically all of his buying in a period of a few months. It is a further characteristic of the agricultural demand that it fluctuates from year to year according to the price the farmer has obtained for his crop in the previous year. Both of these situations have the same effect: companies engaged in this business must have other diversified operations which can carry their overhead in slack seasons.

A hope of rectifying this disadvantage is believed to have been the basis for the expansion of the American Cyanamid Company. It will be recalled that this company depended very largely on agricultural outlets; and it is understood that the acquisition of Calco Chemical Company, Kalbfeisch, Selden, and many other subsidiaries in other fields was designed to reduce this particular type of business risk.

17. Dependence on Prosperity.—This caption is intended to bring

up the question of whether the product under consideration is a necessity or a luxury. A further question is also necessary, namely, is the product designed for sales to manufacturers or for direct sales to consumers? As it happens that most of the more important chemical products are typically producers' goods which are seldom seen in their original form by the ultimate consumer, and as the bulk of the products consuming chemical goods fall in the class of necessities, it is clear that one would not expect chemical products as a whole to be so sensitive to changes in the prosperity of the community as commodities like high-priced automobiles, fur coats, yachts, etc., which are typically luxury goods sold direct to consumers.

Consequently, one would expect the volume of consumption of sulfuric acid, soda ash, etc., to hold up pretty well under all but the most serious conditions. Other products, such as ferro alloys which are sold principally to steel companies for the manufacture of special alloy steels for automobiles, would naturally suffer very markedly in times of depression. In the latter case it is a fortunate thing that, for example, the Electro Metallurgical Subsidiary of Union Carbide, manufacturing ferro alloys, is only one unit out of several others in the same company engaged in other operations. In times of depression, then, other products of Union Carbide such as synthetic organic chemicals, flashlights, illuminating carbon sets which are not so sensitive to changes in prosperity can help to carry the overhead of Electro Metallurgical.

18. Replacement Demand.—An interesting test in determining the economic characteristics of an industry is the question as to what extent its products are used up when they are consumed. A company which sells materials for building construction can hardly expect to get repeat orders from the same building each year. Such commodities are obviously very sensitive to the degree of activity in their particular field; and as that activity may drop to zero in bad times, the risk is considerable.

Fortunately, it is the nature of most chemical commodities that they are completely used up in the process of manufacture in which they are consumed, although there are exceptions to this statement. Nitric acid is completely used up when it is converted into cellulose nitrate, lacquer bases, or trinitroglycerine for explosives, and so on; while, on the other hand, an exception is found in the case of solvents used in the manufacture of rayon or coated fabrics, where recovery is possible. In this case the initial order would be large, but the replacement demand would amount only to the volume required for make-up. The increasing rate at which processes of recovery are being perfected

in all parts of the chemical industry has had a marked effect on the growth and development of chemical companies.

19. Elastic Market.—According to economists, when each successive decrease in price results in a greatly increased volume of demand for a commodity the same is said to have an elastic market. An excellent example of this is observed in the case of cellophane. Thus, it is generally understood that each of the many price cuts in cellophane during the last year or two has resulted in a greatly increased volume of business for the du Pont Company.

20. Commodity Competition.—This caption really has two meanings: first, there is the ordinary economic application, according to which competition for the consumer's dollar between entirely different commodities is intended. An example of this would be in the case of the growth and development of the automobile industry, which is said to have resulted in a decrease in the rate of growth of the clothing industry. Presumably people were spending less on clothes in order to save up to buy an automobile.

The second interpretation, which is more to the point in this discussion, has to do with the competition between different commodities which serve the same purpose or between the same commodity made in different ways. For example, in the manufacture of lacquers it is possible to choose from a fairly wide group of solvents which might be used. Butyl acetate competes with ethyl cellosolve to a sufficient extent to class them as different compounds satisfying the same need. In the same industry synthetic butyl alcohol is now beginning to compete with identically the same product produced by fermentation process.

The effect of both these last types of commodity competition is well illustrated in the increasing risk involved in the business of the Commercial Solvents Company. This company formerly was practically the sole factor in its field. Now every one of its four principal products, butanol, acetone, ethanol, and methanol, is encountering competition from similar materials of synthetic origin.

21. Government Interference.—A very good case of the business risks arising from government interference is to be found in the tariff situation in this country. This is a subject which it is difficult to discuss without involving political controversies, but there is no question that the chemical industry has a great deal at stake which may be affected one way or another by the attitude of our government.

Another instance of government interference has occurred in the last few years in the alcohol industry, where the attempt to enforce prohibition has necessitated a very careful supervision and regulation of

DIVERSIFICATION: WOOD DISTILLATION AT TENNESSEE EASTMAN

alcohol production. At first it was thought that this was a favorable condition of affairs which would result in a greater stabilization of this volatile industry.

22. Foreign Competition.—In many cases the risk involved in foreign competition is coupled with the uncertainty of governmental action on the tariff. For example, the manufacturers of illuminating carbons have recently profited from the increasing tariff on imports of these products. Usually the situation is the reverse, and the risk involved arises from the possibility of a removal of an existing tariff and exposure to competition from products having a cost advantage due to the low standard of living on the Continent. In general, these conditions do not maintain for the bulk commodities of the chemical industry, in which labor is a relatively small item and in which the products are too bulky to stand freight charges from Europe.

The risks involved in foreign competition have probably not exerted a very marked influence on the growth and development of our chemical industry. But it is possible that this is one of the reasons contributing toward the trend to fewer and bigger chemical corporations, since definite advantages accrue to bigger companies, which can afford to maintain adequate lobbying organizations in Washington.

23. Trade Practices.—The typical chemical industry, manufacturing producers' goods which are sold by a relatively few men to comparatively few buyers, whose prices are not published, is particularly

susceptible to underhand practices. At present such practices are mainly manifested in the form of secret price concessions, although there are, of course, other tricks in every trade. It is interesting to note that in many cases the smaller companies have benefited through price cutting. They are more mobile units in a price war and are willing to sell their product even at a slight loss in order to get volume and reduced overhead. Often the bigger companies have had to reduce prices further, and even then have failed to get their share of the volume.

On the other hand, the trend to increasingly large units, each of which is a subdivision of one of the few companies which control the industry, points to a possible change in this situation in the future. The larger companies sell and buy so many different products to and from one another that one would hardly expect them to initiate price warfare if they completely controlled the situation.

24. Growth.—One of the most interesting aspects to study in connection with any industry is that of the rate of growth. Some of the chemical industries have made phenomenal records. Probably the best examples are the lacquer, solvents, rayon, cellophane, and tetraethyl lead industries. Naturally there is a very considerable element of luck as to who gets in on the ground floor when one of these mushroom growth industries gets under way, but in general the companies which go in for research on the largest scale are the ones which miss the fewest opportunities.

The bigger a company grows the less marked will be the effect on earnings of each new development—but it is none the less important. For one of the three leaders of the chemical industry to maintain a growth of 15% or over when the country's industry is only growing at the rate of about 4% or less per year implies a very remarkable record of successful scientific and commercial research work.

There is a lot of luck in development work but the probability is that the bigger the scale on which it is undertaken, the more frequent will be the number of successful hits; and one hit will pay for research work on a great many failures.

25. Special Cost Advantages.—In analyzing any particular company's position it often occurs that through some special good fortune they are benefited by a specific cost advantage. An electrolytic caustic and chlorine manufacturer may have long term power contracts which were entered into at an earlier time and therefore at a more favorable figure than those held by the remainder of the industry. Or a special arrangement may have been made with some company to take a very large proportion of the manufacturer's output on a favorable basis for a

long term of years, as is the case with the Westvaco Chlorine Products Corporation, selling to Union Carbide & Carbon.

26. Location of Plant.—From the point of view of finished goods, it frequently occurs that the most favorable location conflicts with the requirements from the point of view of raw materials. A number of copper smelters have virtually limitless supplies of sulfur dioxide which could be very cheaply converted into sulfuric acid were it not for the bulkiness of this product and the isolated location of the smelter works.

27. Relations to Customers.—A good example of the benefits of a close relationship with customers is to be found in the case of the du Pont Company, which holds a large minority interest in the stock of the General Motors Corporation. Although it is not to be expected that General Motors Corporation would buy an inferior grade of material from du Pont just because of the close connection between the companies, one is not surprised to find that virtually all General Motors lacquers, artificial leather, and so on, are purchased from du Pont.

In this connection it is interesting to theorize to the extent of wondering if the du Pont Company would have become such a potent factor in the coated fabrics industry if they had not had this connection with General Motors. In a similar way, would the du Pont Company have been able to take its position in the tetraethyl lead and synthetic refrigerant fields if they had not been so close to the General Motors Corporation, which developed the application of these materials?

28. Relations with Subsidiaries.—In the preceding paragraph it has been assumed that the producer-consumer relationships were between different corporations. It is one of the outstanding characteristics of the chemical industry, however, that there is a large amount of exchange of products between different divisions of the same companies.

The Union Carbide & Carbon Corporation makes synthetic acetone, which is used by the Linde Corporation in its acetylene cylinders; and it seems reasonable to attribute the economies derived from this type of inter-subsidiary relationship to the large scale diversification of the parent company.

Occasionally the relationship is disadvantageous, as in the case of the Allied Chemical and Dye, where Barrett's $(NH_4)_2SO_4$ must compete with Hopewell nitrate for a limited fertilizer market.

29. Relations to Competitors.—Another test which it is interesting to apply in analyzing the business position of any company concerns its relations with its competitors. Two examples will suffice to bring out the extremes of such relationships.

Probably the best competitor relationship exists between the Air

LARGE PROFITS ENCOURAGE THIS CHEMICAL INDUSTRY. A MOONSHINER'S 1000-GALLON STILL

Reduction Company and the Linde Air Products subsidiary of Union Carbide & Carbon. Undoubtedly one of the principal reasons that the earnings of these two companies are holding up so well in the present depression is the fact that neither company has undertaken to cut the other's prices or steal business on a wholesale scale.

Quite the reverse is the case in the alkali industry, where half a dozen companies were making comfortable profits until recently, when one of the larger organizations attempted to assume a bigger position in the industry. As the principal weapon used in attempting to accomplish this purpose was a price war, one of the results has been a very marked decrease in profits for everyone in the industry. It is understood that, curiously enough, another result is a disproportionate decrease in volume for the aggressor as compared with the competitors.

30. Contracts.—One of the important factors in considering most chemical companies concerns contracts. A very important proportion of the industry's business is done on a contract basis; and the form and terms of these contracts occasionally determine the success or failure of a company. The relationship between the Westvaco Chlorine Products Corporation and the Carbide & Carbon Chemical Company, subsidiary of Union Carbide & Carbon, will serve to illustrate a case where a company practically became successful as a result of the terms of a contract.

In this case the Carbide Company could not foresee how well their

new development of Prestone would go. As there was, for this reason, a considerable element of risk involved, the Westvaco Corporation was able to stipulate that the interest on their investment in plant should be guaranteed. Furthermore, while the terms of the contract are not generally known, it is understood that Carbide guaranteed to pay a certain price for all the chlorine and caustic consumed by them. As this business provided a backlog for the Westvaco Company, they were able to construct additional capacity and make a good profit in competition with the other electrolytic manufacturers. On this basis, in good times the Westvaco Company showed excellent earnings.

31. Good Will and Advertising.—In many industries good will is a vital factor; and this is also the case in such branches of the chemical industry as pharmaceuticals, soaps, cosmetics, and so forth, where consumers' goods are involved. On the other hand, with the remainder of the chemical industry which is concerned mainly with producers' goods, it is usually the case that these products are sold on specification in large volume and that good will is not such a vital factor.

32. Returns and Rejects.—While the question raised by this heading is rarely of real importance, it is occasionally true, particularly with some new enterprise, that an embarrassing amount of the product will be returned by customers. This brings renewed emphasis to the advantage of a large corporation in undertaking some new project. The bigger corporations normally have such a strong financial position that the risk of loss through this type of occurrence would mean very little to the parent company; it also frequently happens that the product being developed by the large company is one which will be sold either to another subsidiary of the same company or to some customer who is already involved in other business dealings with the parent company and who will therefore tend to show a cooperative spirit.

33. Monopoly.—Reference has already been made to the virtual monopoly which exists in the Texan sulfur industry, which is under the control of the Texas Gulf Sulfur and Freeport Texas Companies. The compressed gas industry is also virtually dominated by Air Reduction and Linde Air Products. For a long time the Commercial Solvents Company dominated the solvents industry.

In at least two of these cases the risks which accompany a monopoly in this day and age have led the companies to seek greater diversification by entering other industries. The Freeport Texas Company, as has already been mentioned, has recently become a factor in the manganese industry. Commercial Solvents first went into the titanium pigment business and more recently entered the synthetic resin field.

34. Diversity of Outlets.—One of the most characteristic features of the chemical industry is the diversity of outlets for finished goods. The majority of chemical products are useful to a number of consuming industries: sulfuric acid is used by such diverse consumers as fertilizer manufacturers, petroleum refiners, steel producers, general chemical manufacturers, and metallurgical operations. Similarly, caustic soda is used in the soap industry, petroleum refining, general chemicals, rayon, and a number of other unrelated outlets.

Still another case of diversification which is inherently characteristic of the chemical industry results from the frequent occurrence of by-product operations. These, however, will be discussed later.

Clearly, the great diversity of these consuming outlets calls for unusual distribution and selling facilities; and it is natural therefore that the bigger the organization the more easily such problems can be handled. Consequently, where general lines of chemicals are carried, it is not surprising to find that the most successful companies are the large ones. This is evidenced in the cases of Grasselli and General Chemical Companies. Another instance where the efficient utilization of a nation-wide chain of warehouses is an important factor occurs with the Union Carbide & Carbon Corporation. In this case such unrelated products as dry cells, anti-freeze, compressed gases, carbon brushes, illuminating carbons, and so forth, may be distributed and stocked through the same organization.

35. Full Line.—In many cases a considerable advantage arises from being able to offer a full line of the different products required by the consumer. Thus, a small independent organization can often manufacture a certain dye more efficiently than one of the bigger companies, such as du Pont or National Aniline; but the smaller company may be at a distinct disadvantage in merchandizing its wares, through the fact that it is unable to offer a full line of other dyes which may be required from time to time by the customer.

III. Tests Pertaining to Operations

Industry

36. Labor
37. Mass production
38. Power
39. Initial investment
40. Fixed overhead
41. Over-capacity
42. Process period
43. Obsolescence
44. National catastrophe
45. Local catastrophe
46. Toxicity of materials
47. By-products

48. Waste products
49. Joint products
Company
50. Operating efficiency
51. Research
52. Patents, royalties, and franchises
53. Adaptability of plant
54. Adequacy of plant
55. Balance of equipment
56. Size

36. Labor.—In the modern chemical operation with its large investment in semi-automatically controlled equipment, labor is often a small item. It frequently occurs that such labor as is required must be highly skilled and technically trained. The complicated nature of the operations involved prevents steel manufacturers and railroads, who are large consumers of compressed oxygen, from going into the manufacture of this gas for themselves. Even assuming that the patent situation were perfectly clear, it would be difficult for an outsider to set up and operate his own plant effectively without undue risk of embarrassing shutdowns.

Another place where the ability to provide properly trained men has proved profitable is in the du Pont organization. Early in this company's career, when the risk of explosion was greater than now, the company developed a definite policy of training men as understudies for practically every important post. When the opportunity arose for comparatively enormous expansion in the lacquer, rayon, and tetraethyl lead fields, the possession of an adequate supply of men properly trained in the company's methods was one of the important factors which made it possible for du Pont to proceed with such marked success.

37. Mass Production.—This factor is generally more significant in mechanical operations than in the chemical industry. The assembling and testing of batteries by National Carbon Company is an instance where mass production may provide important economies.

A more typically chemical case occurs in the electric furnace products industry, where the manufacture of calcium carbide is so much more efficiently carried out in large furnaces that the small competitor has practically no chance to enter this field.

In the high-pressure synthesis of ammonia or alcohols, it is also true that production except on a large scale is not profitable.

38. Power.—In a number of chemical industries adequate supplies of cheap power are vital. For example, in the electrolytic caustic and chlorine industry the larger plants ordinarily are located adjacent to cheap hydroelectric power. With the development of increasingly cheap steam power, particularly at locations close to cheap fuel and

ample water supplies, it is possible that a trend away from Niagara Falls may be expected.

Another factor in this situation concerns the increasing demand for Niagara Falls power for public consumption for lighting purposes, etc. It is conceivable that the Niagara Falls chemical companies may find it more profitable to sell back their power than to convert it into chemical products. Already the Union Carbide & Carbon Corporation, which requires a large amount of power in the manufacture of calcium carbide and ferro alloys, is taking a step away from Niagara Falls. In this case, the use of a combination of hydroelectric and steam power is contemplated.

39. Initial Investment.—Another factor which limits certain chemical industries to large chemical companies with ample financial resources is the high initial investment required for economic operation. In the manufacture of soda ash it has been stated that between $5,000,000 and $10,000,000 are required as an initial stake to enter this industry. To enter this game one must have a plentiful supply of blue chips.

40. Fixed Overhead.—In an industry such as the high-pressure synthesis of ammonia, where the initial investment is high, it follows that capital charges may be a significant proportion of total cost, even when operations proceed at capacity. If, as in this case, there is a possibility of enforced curtailment of operations, profits will be rapidly endangered. Consequently, it is not surprising to find that only the Allied Chemical & Dye and du Pont Companies, with their enormous resources, are able to go into this business on a big scale.

41. Over-capacity.—It is an unfortunate feature of some industries that plant capacity far exceeds present demand. The fermentation alcohol industry, for example, is said to have plant capacity about 100% in excess of demand. This situation is very unsettling to the price structure of an industry, as there are always wildcat producers who make price control difficult by their unruly activities. It is natural to expect, therefore, that some of the weaker companies will be forced to go out of business.

42. Process Period.—Where an operation consumes an unusual amount of time from start to finish, the investment charges in the plant per unit of product are occasionally subject to marked economies through the development of improvements which speed up the operation. An example of such a development has occurred in the last few years in the rubber industry with the development of vulcanization accelerators, which resulted in a marked decrease in the processing period. There was, therefore, a consequent increase in the volume of

ONE END OF KODAK PARK

output per unit of plant and a corresponding decrease in fixed charges.

43. Obsolescence.—One of the nightmares of the chemical industry is obsolescence. Many chemical manufacturers have had the sad experience of developing a technically satisfactory process only to find that by the time they got into production their equipment was obsolete. It has been said that one of the first high-pressure plants for the manufacture of synthetic ammonia was virtually obsolete by the time the plant was erected. This again points to the ineligibility of all but the biggest manufacturers for a part in this type of business. The independent producer who banks on the single process which he has developed faces a risk of loss which is frequently greater than the possible reward for success.

Another much worn example of obsolescence in the chemical industry is the case of the wood-distillation industry. The wood-distillation companies manufacture charcoal, calcium acetate, methanol, and acetone. Trouble first developed when progress in the steel industry affected the demand for charcoal, which was formerly used in making charcoal iron. Then acetone came on the market in large quantities as a by-product of the fermentation method of producing butanol. Subsequently, high-pressure synthesis of methanol and the synthesis

of acetic acid from acetylene dealt what are probably final blows to the wood-distillation industry.

44. National Catastrophe.—A number of possibilities are included under this heading. The country may become involved in a great war, a general strike, and so forth. In any case, the companies with widely diversified operations are the least likely to suffer vitally. Certain operations which are favored will carry others which are endangered.

45. Local Catastrophe.—This refers more particularly to the effects of such local occurrences as flood, drought, and so on. Here again the bigger companies with plants located in widely distant localities are less likely to be seriously damaged.

Possibility of drought and subsequent crop failure is probably one of the reasons why the Commercial Solvents Company experimented with the use of rye instead of corn as a base for their fermentation process for butanol. In any case it was fortunate that they had this second string to their bow, because one of the effects of the drought in the summer of 1930 was to produce a scarcity of corn which helped to maintain corn prices somewhat higher in proportion to the other grains. The Commercial Solvents Company's ability to utilize rye was used to advantage.

46. Toxicity of Materials.—Where the product to be handled is toxic, it is evident that a very considerable element of risk exists. Laborers may be injured or even killed, as in the case of the manufacturers who made the radium luminous paste for painting watch dials; or the product may be poisonous to vegetation, as in the case of the sulfur dioxide formerly discharged into the atmosphere by the Tennessee Copper & Chemical Company. In this case it is understood that there was such widespread destruction of vegetable life in the vicinity of the plant that the government interfered. The result was that the company was forced to dispose of its excess sulfur dioxide by converting it into sulfuric acid, a by-product which is now an important contributor to earnings.

47. By-products.—In the preceding paragraph there has just been mentioned an interesting case of a waste product which finally became a valuable by-product. In this way there was provided adequate reason for the peculiar organization of the Tennessee Copper & Chemical Company, which is an important manufacturer of sulfuric acid in addition to the metallurgical products which they originally started out to make.

Reference has also been made to the wood-distillation industry, which provides an excellent example of the peculiar economic conditions that arise from by-product operations. As will be recalled, the nature

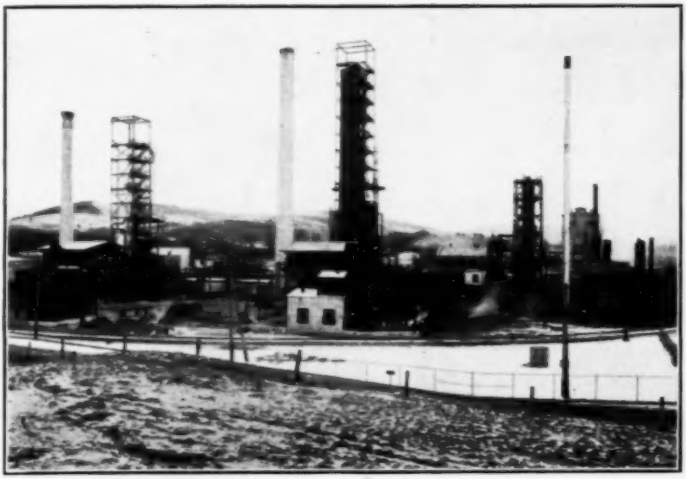
of the process necessitates the production of charcoal, methanol, and calcium acetate. The latter in turn may be used as a source for either acetic acid or acetone. These finished products are inseparably associated, due to their common economic origin; but the economic characteristics of their distribution and marketing are not necessarily related at all. Thus, charcoal is used principally by the manufacturers of charcoal iron, while the methanol used to be consumed principally in the denaturing of alcohol. If the calcium acetate is converted into acetic acid, this may be sold to manufacturers of solvents for lacquers, or to the makers of cellulose acetate products, rayon, or non-inflammable photographic film. Acetone is used as a solvent and in putting up compressed acetylene.

Another interesting case of by-product operations concerns the Commercial Solvents Company. Here the fermentation of corn as carried out by the Weizmann process unavoidably produces butanol, ethanol, acetone, carbon dioxide, and hydrogen in more or less closely regulated proportions.

It is interesting in this connection that the process was originally developed to provide acetone for the manufacture of high explosives during the war. At that time there was no outlet for the butanol; and it was not until its application in lacquers was developed that butanol became the principal product and acetone the by-product. Inasmuch as the relative proportions produced cannot be varied widely, it follows that when there was a demand for acetone, large quantities of butanol had to be stored. Later, when the demand for butanol picked up, it became a problem to dispose of the acetone.

48. Waste Products.—A closely related situation occurs with waste products that are really by-products for which there is no apparent use. In the previous case it will be noted that the Commercial Solvents Company unavoidably produced large volumes of hydrogen and carbon dioxide as a part of the chemical reaction upon which their process is based.

For a long time both these materials were discharged into the atmosphere and lost. Subsequently, however, when the Haber process for the high-pressure synthesis of ammonia and methanol was perfected, it soon became clear that the Commercial Solvents Company was favorably situated to manufacture either synthetic ammonia or methanol. A plant was constructed, and although either material can be made from the hydrogen, it was finally decided to combine the hydrogen with carbon dioxide and manufacture methanol. This is now a profitable source of income to the company.



VAPOR PHASE PROCESS FOR CRACKING PETROLEUM

Again, as there were still considerable volumes of carbon dioxide for which there was no need, it is not surprising to find that in recent years the company has become associated with the DryIce Company, who compress this carbon dioxide for their purposes.

49. Joint Products.—A further closely related classification is necessary to distinguish between true by-products which are unavoidably produced together and joint products which are produced optionally from a single raw material. An example of this latter type of situation occurs in the American Cyanamid Company. Their basic product, as the company's name implies, was originally cyanamid. The principal use for cyanamid as such is as a fertilizer. Subsequent developments, however, led to the manufacture of ammonia therefrom, and this is also used to a considerable extent in the manufacture of other types of fertilizers.

Still later a process was developed for the preparation from cyanamid of a material sufficiently rich in cyanide for use in the refining of gold and silver. This crude cyanide is also a very cheap raw material for the manufacture of prussiates, a line of pigments used in printing.

The same crude cyanide mixture may also be used as a source of hydrocyanic acid for fumigation work and as a starting point for organic synthesis, such as the manufacture of ethyl lactate, a lacquer solvent.

It need hardly be pointed out that from the economic point of view the array of different markets in which these joint products are consumed is imposing. This is an excellent case where there is ample rhyme and reason for a most astonishing economic grouping of industries.

The Dow Chemical Company, which has been mentioned previously, also offers many interesting examples of by-product, waste product, and joint product utilization.

50. Operating Efficiency.—From the point of view of ability to operate complicated and risky economic processes successfully, it is clear that there will be occasional instances of companies which have entered certain industries merely because no one else could cope with the difficulties involved. For example, the du Pont Company is the sole manufacturer of tetraethyl lead, and it is generally claimed that their success with this hazardous problem, on which others had failed, was due to the unusual experience and skill which the company was able to bring to its solution.

It is assumed that mechanical efficiency of engineering operations involving such problems as the proper utilization of waste heat, exhaust steam, etc., is not monopolized by one or even a few companies. However, it seems reasonable to believe that the larger corporations will be in a stronger position as regards the wide range of technical skill at their disposal.

51. Research.—Undoubtedly both scientific and commercial research have been responsible in certain cases for the inclusion of anomalous units in the general organization of some companies. In the case of the American Cyanamid Company there is a single instance in which both commercial and scientific research were involved. This company had, as has been previously stated, developed a considerable business with certain mining companies. From the point of view of the commercial research worker, it was obvious that every effort should be made to discover or develop products which could be sold along with the existing line of mining chemicals. As a result of pressure from this source, it is understood that the scientific research department developed the interesting and useful flotation reagent, "Aerofloat." An outlet was also found in connection with this reagent for certain cyanide derivatives used in flotation processes.

A case of the reverse situation, where the product was discovered first by the scientific research and a market discovered later, occurred in the Union Carbide organization. In this instance it was discovered in the research laboratories that ethylene obtained from natural gas or petroleum-still gases could be converted into ethylene glycol, a compound

similar to glycerine. Intensive commercial research subsequently developed large volume markets for this product in such diverse, unrelated fields as low freezing dynamite and anti-freeze radiator fluid.

52. Patents, Royalties, and Franchises.—It is characteristic of the chemical industry that there is a more or less continuous battle over various patents. In certain cases companies with which every one is familiar have been radically affected thereby.

The striking history of the Commercial Solvents Company is to be attributed directly to the patent monopoly which it was able to maintain in the fermentation industry.

The growth and development of the Bakelite Company was marked with patent litigation, and the final victory in the Redmanol suit resulted in a back royalty situation which could be solved only by merger of the two companies.

It occasionally happens that franchises are important to the chemical industry. One of the reasons for the success of the great Swedish match trust arises from its ability to obtain monopolies in impoverished foreign countries to which the company has loaned money.

53. Adaptability of Plant.—An interesting feature which has had a definite bearing on the economic characteristics of certain companies is the adaptability of plant. A simple case occurred in the high-pressure synthetic ammonia plant of Commercial Solvents. This plant was originally designed as a synthetic ammonia plant, but during the construction period it developed that there was a chance for enhancing profits by manufacturing synthetic methanol. After only a very short period of operating on synthetic ammonia, the plant was converted with very little additional expenditure to the manufacture of methanol.

Another case of such adaptability has occurred with the du Pont Company, which has converted some of its excess rayon equipment to the manufacture of cellophane.

54. Adequacy of Plant.—It is clear that in the growth and development of the chemical industry there will always be instances of companies which get the jump in a new market simply through having had the foresight to construct a plant of adequate size to accommodate the demand. A case which more or less illustrates this point is understood to have occurred recently in the cellophane division of the du Pont Company. The sales department hoped to get the cigarette manufacturers to use a moisture-proof cellophane wrapper. As the contemplated contracts involved large volumes of cellophane, and as the prospective customers could not be kept waiting after the contracts

had been signed, it was necessary for the du Pont Company to construct adequate plant facilities in advance. When the business came, they were in a position to satisfy the demand and profit accordingly.

55. Balance of Equipment.—As it is often the case in the chemical industry that the company's income is derived from the sale of a final product which results from a chain of integrated unit operations, it is clear that one of the outstanding problems of the industry is how to provide for expansion and at the same time keep the various units of the plant properly balanced.

In the case of the Allied Chemical & Dye Corporation's high-pressure synthetic nitrogen division at Hopewell, it was necessary to construct certain units at the outset on a scale commensurate with the eventual capacity of the project. For this reason it is believed that some parts of the equipment installed at Hopewell are not used and will not be used for some time to come. To this extent that plant is unbalanced.

The Dow Chemical Company, which produces such widely diverse and yet intimately integrated materials as epsom salts, calcium chloride, bromides, indigo, phenol, aniline, and so forth, is constantly faced with the problem of maintaining a proper balance between all the different facilities and raw materials required. Thus, an increasing demand for organic or inorganic bromides would require the treatment of a greater gallonage of brine. This means the disposal of larger amounts of epsom salts, or other magnesium products, calcium chloride, etc. The separation of the bromine from the brine requires chlorine. Consequently increased chlorine capacity would be required, which would entail a further expansion of power generating equipment, an outlet for additional caustic, etc.

A somewhat similar situation exists in the case of Westvaco Chlorine Products Corporation, who have recently expanded and altered their plant. The steam which is made to generate power for the electrolysis of brine is tapped from bleeder type turbines under conditions which permit its use in evaporators for the concentration of dilute brines. It is understood that under favorable conditions a very nice balance may be maintained.

56. Size.—The size of chemical operations has already been mentioned frequently as an important factor. In general, the greater the size the greater the security of the enterprise, provided that a satisfactory diversification of operations is entailed.

Strictly from the point of view of unit process operations, it should be observed that in many instances a saving in expense per unit of product is realized by doubling the capacity of such equipment as stills,

evaporators, rotary filters, columns, and so forth, since little, if any, extra direct labor or supervision is required.[1]

There is one example, at least, in the chemical industry where small size is said to be advantageous. This occurs in the agricultural chemical industry, where a large number of small mixing units widely distributed throughout the country are understood to have advantages from the point of view of utilization of raw materials and distribution of finished products to a market whose requirements vary from county to county.

IV. Tests Pertaining to Management

57. Personal characteristics
58. Record of achievement
59. Administration cost
60. Self-perpetuation
61. Expansion policies
62. Dependence on external financing
63. Proportion of earnings paid out in dividends
64. Misstatement of earnings or assets
65. Stock control

57. Personal Characteristics.—There can be little doubt that the personal ambitions of individual corporation executives have frequently had a determining effect on the growth and development of their companies.

58. Record of Achievement.—Where the future trend of development of an organization is in question, it is generally of interest to consider the past record. Thus, a management which has established a reputation for stressing research may be expected to derive some benefits therefrom in the future. Again, a company which has frequently been involved in price wars is apt to meet such difficulties again.

59. Administrative Cost.—It has occasionally happened, more particularly in small enterprises, that the management is adequate but is so costly that the project is at a disadvantage with its competitors.

One of the most potent advantages to be derived from large-size operations has to do with the ability of such organizations to obtain better management at a smaller cost per unit of output. There is a danger of course, that such a management will spread itself so thin that adequate attention will not be given to details; but on the whole it seems probable that the advantages operate the other way.

[1] *Chemical Engineering Economics*, Chaplin Tyler, page 6.

60. Self Perpetuation.—It frequently occurs in the chemical companies, as in those of other industries, that the management has been dominated by a single personality. In any particular case, especially as the period of usefulness of an individual's life approaches an end, the development of the company may be seriously involved. Or again, as often happens in profitable enterprises which have been in the same family for more than one generation, the heirs may not choose to give a proper amount of attention to the affairs of the company.

61. Expansion Policies.—A case where the conglomerate nature of the industrial groupings in a large chemical organization is particularly plain occurs in the American Cyanamid Company. Here it is believed that the management formulated a definite policy of expansion with the sole view of obtaining greater diversification to dilute the risks involved in their agricultural chemical business. Consequently, it is not surprising to find this company acquiring many apparently unrelated subsidiaries.

62. Dependence on External Financing.—It has occasionally happened that a large chemical company has acquired a seemingly unrelated subsidiary merely for financial reasons. In such a case the parent company may have better facilities for raising capital to finance a further expansion of the newly acquired subsidiary. Or, possibly the smaller company may have gotten itself in temporary financial difficulties. In many cases the American Cyanamid Company was able to provide funds for renovating and expanding equipment of its recently acquired subsidiaries.

63. Proportion of Earnings Paid Out in Dividends.—During the recent industrial prosperity it was characteristic of the better managed chemical companies that not much more than half their earnings were paid out in the form of dividends. In this way a company was frequently able to provide for moderate expansion without external financing. The Allied Chemical & Dye Corporation is an outstanding example of a company which has been able to provide for expansion without appeal to the public. While both du Pont and Union Carbide have raised money by public subscription, the funds so raised were small in proportion to total outlay for plant additions.

64. Misstatement of Earnings or Assets.—During the boom years it was frequently boasted that such and such a chemical company was hiding several dollars of earnings per share, and in many cases conservative managements undoubtedly did follow some such practice. In the case of the Air Reduction Company it is understood that the management's ultra-conservative depreciation policies with reference to

certain equipment resulted in a situation where certain pieces of apparatus have been completely depreciated although they are still in use. This will improve the showing of this company in the present hard times.

Nothing has been said regarding over-statement of earnings or assets, but instances of this so infrequently come to one's attention that it may be disregarded.

65. Stock Control.—While it may seem a long step from this topic to the search for rhyme or reason in chemical organizations, it is interesting to observe that in certain cases it is believed that the influence of important directors or other stockholders has had a very marked effect on the growth and development of chemical companies.

V. Tests Pertaining to Earnings

66. Growth
67. Stability
68. Margin of profit
69. Return on investment
70. Return of capital
71. Equity in undivided earnings of subsidiaries

66. Growth.—Obviously one of the essential features in the growth and development of our chemical companies has been the favorable trend of growth in earning capacity. Thus, profits from one rapidly growing division were available for extra research and development work which resulted in expansion of other divisions.

One outstanding case of this type of development has been the du Pont Company, which has augmented the position it obtained during the Great War by the development of lacquers, rayon, tetraethyl lead, cellophane, synthetic ammonia, and other extremely profitable products. It is interesting that in their last annual statement this company announced that a sum of more than $5,000,000 was expended on research in the depression year of 1931. Such expenditures should produce results.

67. Stability.—Another interesting factor which bears on the economic characterization of a company is the stability of earning power over a number of years. In an ordinary organization of the interrelationships between the various unit processes which generally exist, any one chemical company is naturally greatly favored by stability of earnings.

In the soap and photographic industries one would expect that the

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annual budgeting of expenditures including the allowance for research, could be readily and accurately accomplished; whereas, in a less stable industry one would hardly expect that a carefully laid out plan of procedure, especially with regard to research, could be so readily adhered to.

68. **Margin of Profit on Sales.**—Where a large part, say 50%, of the sales dollar is profit, it is natural to expect that other competitors will be tempted to enter the field unless there is an ample fortification of patents or other protection. If competition already exists, the danger of a price war is imminent, particularly in times of depression. For these reasons the companies which have been characterized by large profit margins have frequently been the most zealous searchers for new fields to conquer. Such a company as Allied Chemical & Dye, with its formerly highly profitable alkali industry, is supplied with adequate funds for the development of new enterprises and at the same time is faced with the risk mentioned above. Possibly this situation was a contributory factor to Allied's expansion in the nitrogen field.

69. **Return on Investment.**—Where the profits derived from an investment in chemical plant represent a high return on capital invested, the same conditions maintain as in the case of a high margin of profit on sales. In this connection, however, it should be recalled that the minimum economic investment is significant.

Thus, the return on investment may be high, but if the minimum economic investment is several million dollars, as it is in the case of the Solvay process alkalies, petroleum refining, rayon, and so forth, it is clear that there is a serious obstacle to competitors who wish to enter the industry.

70. Return of Capital.—In general, chemical industries buy their raw materials, but occasionally natural sources are depended on. For example, the sulfur companies are engaged in the business of extracting the natural product from the ground. In this case it is clear that depletion of the company's reserves of raw material in the ground is a significant factor. As the problem of estimating the extent and quality of reserves is by no means simple, it is apparent that an element of risk enters into any such situation. Consequently, one would prefer to have companies so engaged dilute their risk by entering into other operations; and, as we have already mentioned, the Freeport Texas Company has recently taken a step in this direction by entering the manganese field along.

71. Equity in Undistributed Earnings of Subsidiaries.—From the point of view of a true statement of earnings it is evident that a parent company with many subsidiaries can readily hide earnings if the subsidiary company's statements are not consolidated or made separate. This occurs particularly in the case of companies with foreign subsidiaries. It is mentioned here, as it is conceivable that an ultra-conservative management might consider this possibility as an important reason for the formation of foreign subsidiaries.

VI. Factors Concerning Financial Position

A company's financial position is ordinarily determined by the figures itemized in its financial statements. Volumes have been written about the proper relationship between such items as Cash, Receivables, Inventories, Payables, Sales, and so on. Wall and Dunning in their book entitled *The Ratio Analysis of Financial Statements* have made a very thorough study of this subject. A briefer summary is included in Hatfield's book entitled *Accounting*. In these works helpful methods are provided for anyone whose sources of information are limited to balance sheets and income accounts.

It is unfortunate that the published statements of many important companies, especially in the chemical field, are so arranged that ratio analysis reveals little information of interest about the innermost workings of the company's business. True, a company's annual report is the

ultimate quantitative statement of its financial position; but it is often impossible to detect therein the workings of many of the important factors which have been discussed in this paper.

Few of the leading chemical companies show even their sales in their annual reports. In those cases where sales are shown, it is impossible to interpret the trends from year to year unless one is possessed of accurate knowledge regarding the volume of output sold and the average price received—information which is closely guarded in most cases.

It is characteristic of the chemical industry that the larger companies are often engaged in a heterogeneous mixture of operations whose economic characteristics differ widely in any one organization. One company is merchandising two such unrelated products as calcium carbide sold in bulk to manufacturers on contract, and flashlight batteries, sold in units to the ultimate consumer over chain store counters. What is the significance of this company's ratio of total inventories to total assets unless one can break down these figures by items?

In other cases, where balance sheets and income accounts give only figures which are composite statements of a confusing array of wholly unrelated enterprises, it is difficult to see how the ordinary methods of ratio analysis can be expected to yield worthwhile results.

Where the chemical industry is concerned, the ordinary methods of analyzing financial statements are inadequate. Even a qualitative knowledge of the company's business is of more service; and in the preceding sections of this paper an effort has been made to outline a method of attack of such a nature. Although in the present treatment most of the factors considered were discussed in a qualitative manner it is evident that many of these factors are susceptible of quantitative treatment, provided adequate information is available.

To obtain such information would seem at first glance an insurmountable task. Having determined, however, that a group of three or four factors are of vital significance in measuring a company's prospects it is frequently possible to obtain enough semi-quantitative information to permit an adequate analysis of the situation.

NOTE: *The* CHEMIST is indebted to *Chemical and Metallurgical Engineering* and to the Eastman Kodak Company for the pictures used in illustrating this article.

Chemistry in Stream Sanitation

By Glenn V. Brown

A discussion of the method by which the chemist is solving the increasing problem of water pollution. Stream sanitation as practised by the state of Pennsylvania.

A NOTED biologist has said, "The conditions of the waters of the earth determine not only the health and the wealth of the aquatic inhabitants, but as well even the continued existence of mankind." In 1926, Dr. Monger, of the Ohio Department of Health, stated that "at no distant date water protection will probably be the livest question confronting the sanitarian."

The pollution of streams is one of the penalties of civilization. Potential and actual health hazards increase as the water supply resources come in closer proximity to the domestic and industrial waste discharges. With the increase in population and in industrial activity, the problem of the prevention of stream pollution has therefore become a conspicuous item in the public health and sanitation programs of many states.

A study of the literature on stream pollution shows that foundations have been laid for a real scientific study of "potamology" or river science. Methods are in use which enable us to determine the conditions of a stream at any point, the rate of self-purification of the stream, and the improvements which will follow changes in the character or volume of specific liquid wastes discharged to it. That is, we can measure pollution at its source by its effects farther down stream.

Chemical Determination of Pollution

Wastes which contribute to the pollution of streams may be classified as inorganic or organic. Inorganic or mineral wastes are determined by the well-known methods of chemical analysis. Organic wastes are putrescible or subject to decomposition by bacterial action, and when decomposing in water reduce its oxygen content.

If there is a deficiency of dissolved oxygen in the solution (or suspension) of the waste, the elements which form the organic compounds rearrange themselves to form substances lacking in oxygen. Anaerobic decomposition will take place and a foul or septic condition will result.

If the dissolved oxygen of the solution is in excess of the "oxygen demand" of the waste, complete biochemical oxidation or stabilization will take place and the excess oxygen will remain in the solution. The "oxygen demand" of an organic substance is the measure of its potential polluting strength on streams.

Suitable chemical tests determine the oxygen demand or pollutional value of a putrescible waste. This, with the daily production of the waste, gives its daily total of oxygen demand. Chemical tests show the oxygen content of stream and this, combined with the volume of flow, gives its total available oxygen. These data, with proper consideration given the reaeration factors of the stream, indicate how far down stream a specific waste exerts its influence. Using the average per capita oxygen demand of sewage as a standard, the "equivalent population" of any specific organic waste is readily determined.

Special Features in Pennsylvania

The sanitary stream surveys in Pennsylvania have some unique features. Most of the work is done in mobile chemical laboratories. These are specially built bodies mounted on high-speed chasses. At times they are accompanied by small passenger automobiles as "feeder" cars. Each mobile laboratory is a separate unit and is equipped with water, gas, and electricity. They are provided with twenty-degree Hearson incubators and with the chemicals and apparatus necessary for the sampling of streams and the determination of temperature, alkalinity, hydrogen-ion concentration, per cent saturation, oxygen, and biochemical oxygen demand. They also have the materials necessary to determine the effects of coagulants and other chemicals on industrial wastes.

The laboratories now under construction are provided with refrigerating units and with the apparatus necessary for field bacteriological work. When in the field, these laboratories are directed by a chemical engineer who has under his supervision a driver assistant and the chemical force necessary to carry on the work.

Industrial surveys are an essential part of most of the stream pollution studies in Pennsylvania. Preliminary visits to the manufacturing establishments indicate the plants discharging wastes which may be prejudicial to the streams. Chemical and physical tests are made on the separate and composite wastes from these plants. The results of these tests indicate the possible treatment which will render the various effluents harmless and unobjectionable. Abatements or improvements are suggested by the Sanitary Water Board, and its chemical engineers

and chemists keep in close contact with the installation of the suggested treatment or purification plants.

Same Plan in Other States

The "Pennsylvania Plan" has been adopted by a number of states. Its keynote is the amelioration or abatement of industrial wastes through the cooperation of the representatives of the various industries with the State authorities. The State of Pennsylvania has entered into co-operative agreements with five major industries. Chemical work has been indispensable in the efforts of three of these cooperative units. A large number of effluents from the bituminous coal mines have been tested. Laboratories have been established and chemical research has been done on waste effluents from pulp and paper mills and tanneries.

There are numerous examples of chemical research in stream pollution. The U. S. Public Health authorities have made comprehensive studies of streams. Experimental work bearing on stream pollution is carried out at their laboratories in Cincinnati. Other work of a conspicuous character along these lines is that of the Sanitary District of Chicago. The Iowa State College has investigated creamery and beet sugar wastes; Wisconsin, pea cannery and pulp mill wastes; Ohio, milk, phenol, acid iron, and other wastes; Michigan, cannery and beet sugar wastes.

The general plan of the study of the pollutional value of industrial

wastes is essentially the same, namely, chemical studies of the specific wastes and their effect on streams, the installation of experimental plants based upon the results of the preliminary studies, and finally the construction of work-size recovery or treatment plants designed along the lines proved practicable.

Chemical Research

A specific illustration of the cooperation of an industry with a state is shown in the efforts and results of the Tannery Waste Disposal Committee of Pennsylvania. The Committee was organized in September, 1924. A technical representative of the Sanitary Water Board was made chairman; and the members were chief chemists and engineers chosen by the industry from the companies signatory to the agreement.

This committee at once proceeded to collect basic data on the quantity and composition of the various waste waters discharged from tanneries. Then followed twenty months of chemical research on the effects of mixing certain tannery effluents, the coagulating effects of different chemicals, and similar subjects. Over one thousand tests were made in this phase of the work.

Based upon these data an experimental plant was constructed in the fall of 1926 at a plant which was cooperating in the work. During the operation of this experimental plant, studies were made at five stations on a twelve-mile stretch of the stream to which the wastes were discharged. The railroad which served the tannery ceased to operate and a new and full-sized experimental treatment works was constructed at Emporium in September, 1927.

A report of the committee states, "Systems of treatment have been devised in successive steps, each providing an added degree of purification. It is believed that at most tanneries a plant can be installed capable of purifying the wastes to a degree necessary for their harmless assimilation by the stream into which they are discharged."

Plans are now under way for the installation of treatment works in the tanneries of the state. The result will be a substantial reduction in the pollution of Pennsylvania streams.

The Applicant for a Patent

By Charles W. Rivise

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A patent attorney sets down the rules that must be followed in deciding whose name is to go on a patent.

THE patent law makes it essential to the validity of a patent that it shall be granted on the application, supported by the oath, of the original and first inventor. This is true whether the inventor retains title to the invention himself or assigns it to another. The only exception to the rule is made in case the inventor dies or becomes insane before the papers are filed in the Patent Office, in which case his executor, administrator, or guardian may sign them.

The strictness with which the rule is applied is illustrated by the following decisions:

Brewer-Tichener Corp. *v.* American Forging and Socket Company (300 Fed. Rep. 335), involving Patent No. 1,034,899, for a folding top for a vehicle. The application had been signed and sworn to by the inventor in the name of a German firm, "Traugott Golde," of which he was a member. Both the attorney and the patent examiner assumed that this was the name of the inventor, and an invalid patent was the result.

Kennedy *v.* Hazelton (128 U. S. 664). The defendant had agreed for a valuable consideration to assign to the plaintiff any patents he might obtain on steam boilers. Later he sought to evade the terms of the agreement and defraud the plaintiff by the simple subterfuge of having a third party apply for the patent. The patent was held to be invalid because it had been granted on the application of one who was not the inventor.

As a general rule, any person, regardless of race, nationality, citizenship, residence, or sex may obtain a patent in this country, provided he is the first and original inventor and can comply with all the prerequisites and conditions. Employees of the United States Patent Office constitute the only exception. They can neither obtain a patent in this country nor secure any right or interest in a patent except by inheritance or bequest. However, there is nothing to prevent an employee of the Patent Office from obtaining a patent in a foreign country.

It occasionally happens that several persons apply for a patent on the same invention at about the same time. In such case the Patent Office generally refuses to grant a patent to any of the claimants until it can determine which of the applicants is really the first inventor. The proceeding by which this is done is termed an interference.

Sole and Joint Invention

If several persons contribute mutual counsel, mutual suggestions, and mutual effort which result in a unitary invention, they are joint inventors and all must join in filing the application. If any one of them fails to sign, no valid patent can be granted. A case in point is that of In re Crane (1903 C. D. 332). Crane filed an application for a patent, alleging that it was a joint invention and that the other inventor had refused to join in the filing of the papers. The Commissioner refused to accept the application, on the ground that he had no authority to grant a patent on a joint invention unless both inventors subscribed to the oath.

The same result follows if a person who had no part in creating the new device files the application in his own name or joins with the true inventor in signing the papers. In this connection it must be emphasized that one who makes a financial contribution and nothing more is not a joint inventor. He may secure an interest in the invention by means of an assignment from the inventor, but he must not join in signing the application.

In order to constitute two or more persons joint inventors, it is not necessary that the inventive concept come to all of them at the same time. It is sufficient that the invention be the result of mutual counsel, mutual suggestions, and mutual effort. Some of the elements or features of the invention may have been contributed by one and the other features by the others, but the features contributed by each must be interrelated and contribute to a unitary result. In other words, the contributions of the co-inventors must result in a patentable combination.

The mechanism of joint inventorship is aptly illustrated by the following decisions:

Wm. R. Thropp & Sons *v.* De Laski & Thropp Circular Woven Tire Company (226 Fed. Rep. 941), in which was sustained Patent No. 1,011,450 to De Laski and Thropp for a tire-wrapping machine. The patentees testified that most of the machine had been designed by Thropp. De Laski's contributions were directed to the designing of the tension on the bobbin, placing the shafts carrying the pins at angles, and deciding upon the shape of the tripod which produced the pressure. Thropp conceived the idea of exerting pressure upon the tire while it was being wrapped. It was decided that the patent had been correctly issued to both De Laski and Thropp.

Cheshire *v.* Cox Multi-Mailer Company (229 Fed. Rep. 415). Patent No. 971,245 to Brewer and Cheshire disclosed and claimed a feeder for printing presses. The evidence showed the following to be true: Cheshire had hit upon the idea that books and pamphlets might be segregated from each other by causing them to be held in the hopper in a curved position so that either the top or the bottom book or pamphlet would stand out from the body of the books to be passed on to the printing cylinder to such a degree as to engage the vertically adjustable feeder points. Brewer not only provided the finger points, but also suggested the base plate with upwardly curved edges, which was first made flat and then, at Cheshire's suggestion, curved downwardly at the edges. Both worked on the combination and finally agreed on a device having a concave reciprocating base plate curved transversely of its path of travel and having feed fingers to expel the lowermost book on the base plate. Brewer and Cheshire were held to be joint inventors.

In both the illustrative cases, it clearly appeared that one of the inventors had conceived a general but imperfect idea of the new machine which without the conception of the other inventor developing it and contributing essential elements, might never have amounted to invention. The conceptions of one supplemented and complemented the conceptions of the other to produce a unitary and patentable invention.

Must Impart Patentability

A different result might have been reached if the contributions of one of the inventors did not impart patentability to the combination which is the subject of the alleged joint invention. A case in point is that of

Joseph Ross & Co. *v.* Wigder (290 Fed. Rep. 788), involving Patent No. 1,255,819 to Moffatt. Moffatt, the sole patentee, testified that the idea had occurred to him to tin-plate manicure files. Not knowing anything of the technique, he consulted King, an expert, who stated that plastic tin-plating rather than ordinary tin-plating should be tried. Moffatt went a step further and suggested that the plastic tin-plating be done over nickel plating.

The court held that if this story were true, successful tin-plating of manicure files appeared to have been the joint work of both Moffatt and King and that both should have applied for the patent jointly. But, on further consideration, the court decided that Moffatt's suggestions had not contributed any patentable feature to the final process and that the invention was really the sole work of King. In any event, the patent was invalid, having been issued to Moffatt.

It follows from the foregoing discussion that a joint patent cannot be defeated by showing merely that some of the elements of the combination were contributed by only one of the two inventors. Patent No. 681,234 to C. H. and H. C. Krause disclosed and claimed an ore crusher consisting of a stamp, a mortar for crushing ore, a screen through which ore is discharged, and an auxiliary discharge for free metal too large to pass through the screen, consisting of a conduit leading downwardly out of the mortar and a water supply connection leading into said conduit and adapted to produce an upward current therethrough. The defendant in the case of Quincey Mining Co. *v.* Krause (151 Fed. Rep. 1012), contended that the idea of placing the outlet outside of the mortar was the thought of but one of the inventors. The Court decided that the truth of this contention would not affect the validity of the patent, since it covered a combination of elements.

A contrary result would have been reached if the invention had but a single element or idea. A case in point is that of Welsbach Light Company *v.* Cosmopolitan Incandescent Light Company (104 Fed. Rep. 83), involving Patent No. 407,963 to F. L. Rawson and W. S. Rawson for a method of making an incandescent lamp mantle.

One claim covered a method of making a mantle in the following manner: stretching the impregnated knitted mandrel, burning the mantle, shaping the mantle against the mandrel by means of a blowpipe flame, and finally coating the mantle with paraffin to strengthen it. The other claim merely covered the single step of strengthening the mantle by coating it with paraffin or other suitable material.

The Court held that the claim consisting of a number of steps might well have been the joint invention of the Rawson brothers, but it could

not apprehend how both could have shared in the single idea of strengthening the mantle by coating with paraffin.

A similar conclusion was reached in the case of Stewart *v.* Tenk (32 Fed. Rep. 655). Patent No. 140,315 was issued to Stewart and Tenk as co-inventors. The patent included several claims covering an apple paring and coring machine and a single claim to an arched coring and slicing knife designed to be used as part of the machine. The machine as such was undoubtedly the joint work of both patentees, and claims thereto were sustained. The knife, being but a single element, could not very well have been a joint invention. In fact, Stewart testified that it was he alone who had designed it. The claim covering the knife, therefore, was invalidated as having been improperly included in a patent issued to joint inventors.

It is very important in cases involving joint inventorship that extraordinary care be exercised that every claim in the joint application cover the joint work of both workers. This is particularly true, as has been pointed out above, in cases where the essence of a claim consists of but one inventive thought.

If there is any doubt as to whether a person is a joint inventor, it is advisable to have him sign the application. If it should later appear that he is in fact not a joint inventor, his name can be eliminated from the application with his permission, provided it has not yet matured into a patent. On the other hand, the omission of a joint inventor's name from an application cannot be supplied or corrected, except by filing another application. And it often happens that by the time the mistake is discovered the device or the invention has been in public use or on sale for more than two years, in which case it is too late to file another application.

In conclusion it may be stated that courts require very strict proof on the question of joint invention before invalidating an otherwise valid patent on this ground.

NOTE: This article is based upon the author's forthcoming book, *Chemical, Electrical, and Mechanical Patents.*

Abbreviations

C.D. *Commissioner's Decisions,* published by the Government Printing Office for the United States Patent Office.

Fed. Rep. *Federal Reporter,* published by West Publishing Company and containing decisions of the Federal Courts.

U.S. *United States Reporter,* the official reports of all decisions rendered by the United States Supreme Court.

All these reports are available in large city libraries as well as in the Patent Office.

The Point of View

By J. C. Cole

THE tall stacks are cold, the mills by the river are silent.
A chemist has put them out of business, a man with a test-tube has ruined them.

Thousands of men are out of work, ten thousand workers are seeking a new industry.

Fortunately, there will be new industries ready to receive them—
Also because of the test-tubes.

It is the same in India, it is the same everywhere.

A million Hindus wish the chemist had never synthesized indigo,
But their children will eat more because of the increase in the number of wheatfields.

The chemist thinks:

Give me earth's crudest materials,
Tell me the things you want done.
I'll make wine from unpromising cereals,
I'll make vitamin A without sun.

Nature's tints in my crucible burning
Put my acts on a par with the gods'.
I'll watch new molecules turning
Into beans that have never seen pods.

I'll forge in the fire of my burner,
I'll wring from columnular stills
The wealth to make stock markets sterner,
The goods to cure all of our ills.

Ten thousand miles of forest stand uncut because of a catalytic process for making alcohol.

Because of a new fertilizer blades of corn are growing where only weeds grew a month ago.

The chemist has made new steels that will never turn to rust in the beams of our skyscrapers.

The men who formerly built skyscrapers will now build homes and golf courses.

Perhaps the race will eventually have time to stop and enjoy life.

The world thinks:

Chemists are a funny race,
Partly druggist, wholly base.
Here's a spot upon my vest—
Take it off, or do your best.
Use your logarithmic slipstick,
I must have a kissproof lipstick.
Help me make synthetic booze.
Give me pills to make me snooze.
What's the matter with this varnish?
What makes all my silver tarnish?
Chemist, can't you cure my cold?
You're a charlatan, I'm told.

In Borneo the tigers will roam in the rubber plantations because a bad odor has been made into Duprene.

A man in Bayonne has added forty million dollars to the petroleum industry.

The South Sea copra traders will make more money because a new use has been discovered for coconut oil.

The invention of laminated Bakelite was worth millions to the human race.

But what's the use of being chemically oracular,
When gold strikes and bull markets are much more spectacular?

The Chemist's Influence in Agricultural Economics

By B. G. Klugh

The vice-president of Swann Research, Inc., discusses the latest development in agricultural chemicals. A revolutionary new fertilizer.

THE purpose of this paper is to describe a new type of fertilizing chemicals, and the novel processes developed for their commercial production. Such a discussion emphasizes the fundamental factors determining the course of the development, and establishes its close relation to human interests.

The chemist prospers in direct proportion to his service to ultimate interests of mankind. The ever-present human demand is food and raiment. Both are derived essentially from the soil—upon which civilization imposes increasing demands. Any nation's existence depends upon the proper nutrition of its people, and this can only be assured through a fundamentally sound economic status of agriculture, and hence of the agriculturists.

The past few decades have established the absolute necessity of artificial fertilization of the soil for the adequate and economic production of the needs of the people dependent thereon. In a large measure the final cost of specifically effective fertilization governs the cost of the farm product, which in turn determines the profitable continuance of agricultural enterprises. The true index of the value of fertilizer lies in the cost of its application; that is, the total cost of a given increase in value through increased quantity or quality, or through improved control of time of delivery of any farm product. This true cost comprises the total cost of the fertilizer divided by the value of increase

in crop attributable to the application, a method of accounting which provides the only sound means for the comparative evaluation and selection of fertilizer. It is the only basis upon which the fertilizer industry can continue economic existence.

Strict Economic Requirements

It is perfectly obvious that the business of fertilizer-chemical production will be conducted on reasonably narrow margins in the future. Avoidable costs must be eliminated in every phase of the production: processing, packing, transportation, distribution, and utilization, from the most remote raw materials to the ultimate finished product.

Especially vital is the selection of proper chemical combination and physical form of the elements required for effective fertilization. The various industries involved must deliver to the farmer the fertilizing materials effecting maximum returns at minimum cost.

This essential coordination of the chemical and agricultural industries will succeed in proportion to the coordinated activities of the chemists in all inter-related fields. No one branch of specialists can achieve the required economic ends alone. All the interested groups of trained scientists must cooperate. Soil chemistry, agronomy, plant physiology, and other pure and applied agricultural sciences must ascertain the specific needs for optimum effective fertilization. These may in turn be supplied through research by the chemists and technologists serving the vast fields of kindred chemical production. Such a program of coordinated development, once established, will serve all human interests with increasing benefits.

New fertilizing chemicals, carrying potentially effective economies, can have their actual value proved only by field tests. The modifications required are entirely determined by the chemists and scientists concerned. Through such cooperative chemical research the value of the human unit will be advanced as the unit of cost of effective fertilization is decreased.

The research and development of our new form of fertilizing chemicals were predicated upon the foregoing economic and technical considerations.

Beginnings of Research

The Swann Chemical Company has had at Anniston, Alabama, since 1920, extensive electric furnace phosphoric acid production operations. This phosphoric acid process was described in some detail in the November, 1929, issue of *Chemical and Metallurgical Engineering*.

The product went primarily into the food and chemical markets and was a substantially pure phosphoric acid containing over 90% H_3PO_4. Having developed this process for cheap and practically pure P_2O_5 in unlimited quantities, the logical procedure was to reach into the fertilizer markets. This matter was subjected to intensive commercial research investigations over a period of years. Parallel chemical and mechanical research were also carried out as well as some production.

A number of the fertilizer production ventures failed, primarily due to violation of the principles of agricultural economics. It is obvious that any new fertilizer development must provide new advantages in order to justify its place in the already over-produced markets. Before establishing any definite research program, an exhaustive study was made of the existing fertilizer industry in its economic relation to the agriculture it served. Certain fundamental principles are so obvious as to require adoption as definite standards. Other factors are either undetermined, in spite of the immense amount of soil research expended thereon, or are so controversial that reservations must be made to cover them in the future as alternatives.

Advantages of Concentrated Fertilizers

The potential advantages of concentrated versus low analysis fertilizers are obvious. The actual advantages have been controversial and undetermined, since their adoption by farmers has been very limited. Obvious advantages lie in the immense savings direct to the farmer in packing, freight, and handling costs, in greater solubility, hence quicker availability, and in the elimination of ballasts and carriers for the essential plant food elements.

The combining of the plant food elements of nitrogen, phosphoric acid, and potash among themselves, rather than with useless and perhaps deleterious agents, provides great potential advantages from both economic and technical standpoints. A number of highly concentrated fertilizers have been on the market for the past six years. They are made up with the same ratios of N, P_2O_5, and K_2O as are some of the most widely used low analysis fertilizers. In their introduction the most intensive and scientific sales promotion methods have been employed, under direction of outstanding trained agronomists. Many official and private plot and pot tests have demonstrated and proved the efficacy of the fertilizing chemical content. They have been offered at substantial reductions in price below that of the normally used fertilizers.

In spite of these facts, the sales in the United States of complete

ELECTRIC FURNACES FOR PHOSPHORIC ACID MANUFACTURE

mixed fertilizers, containing over fifty per cent of plant food, constitutes less than one per cent of the total in terms of plant food content. The explanations publicly presented for this phenomenon have been largely along lines of antagonistic propaganda and controversy. Little or no constructive evidence has been brought forth that suggests means to convert to the farmer's realization the potential savings through concentrated fertilizers. Even some recently expressed editorial opinions, in authentic scientific periodicals, interpret the coolness toward concentrated fertilizers as evidence of some underlying but unknown defect, and suggest acceptance of such a condition as a ban to further progress toward ultimate agricultural economies.

Research Discloses Source of Trouble

The underlying obstacle to more extensive adoption of concentrated fertilizers appears to have been disclosed by the Swann research chemists' exhaustive study. These difficulties lie in the physical, rather than the chemical, state. The necessity for far greater accuracy of control in the application to the soil of the more highly concentrated goods appears either to have been overlooked, or the means for such control unattained.

The necessity for accuracy in uniformity of application of a fertilizer increases with its plant food content. If the concentration is increased from 16% to 64% plant food, the application rate is reduced to one-

fourth. The chance of error is increased four times, hence the means for accurate control of application must be four times as great. In concentrated fertilizers, made from substantially pure salts, the tendency is toward decrease in characteristics conducive to uniformity of application to the soil.

The salts available for complete concentrated fertilizer production include mono- and di-ammonium phosphate, ammonium nitrate, urea, and potassium nitrate, phosphate, sulphate, and chloride. Two properties of this class of salts prevent the production of a permanently uniform mixed fertilizer in the commonly available crystalline form. These properties are as well defined as the established laws, but are not conspicuously set forth in the literature. They are: first, a mixture of crystalline salts will cake under atmospheric moisture conditions vastly more readily and completely than any of its simple constituent salts; and second, two or more crystalline salts cannot be brought to a thoroughly homogeneous admixture.

The first can be proved by the simple experiment of placing in an open room piles of the single salts and of the best attainable mixture thereof. The mixture will be found to have formed a hard cake when the single salts are still in free flowing state. The second property may be positively demonstrated by coloring crystals of two or more salts differently and placing them in a bottle to about one-half its capacity. No complete homogeneous mixture can be obtained; and the salts can be separated entirely by a vibratory motion.

Pure Salts Hard to Apply

This inherent caking tendency of mixed crystalline salts prevents the producing of complete mixed concentrated fertilizer that the farmers can apply to the soil with required economic accuracy, or with sufficient control in relation to the seed. Even should abnormal conditions provide the delivery of a crystalline salt-mixture in free flowing state, the various salts will separate under the drilling and handling treatment, so that the predetermined ratio of the plant food elements is not distributable among the several plants with any degree of uniformity.

Considerable effort and money have been expended toward producing more or less uniform and coherent aggregates. The uniformity of size of particles, with freedom from dust and hygroscopic resistance, does not appear to have been obtained to a sufficient degree to compete with low-grade fertilizers.

Numerous tests of the drillability of many products upon the market and with products of early research efforts of the Swann Chemical

Company were made by conventional methods and with standard fertilizer drills. The variations were found to be from fifteen to fifty per cent for single rows. Obviously a much greater accuracy is required to render the application of high-priced concentrated fertilizer of any economic interest to the farmer.

In this research program, all the agglomerating and granulating procedures that produce an uncontrolled haphazard size and shape of particle were discarded as inadequate. Attention was directed exclusively to means for forming each particle under exact control. After numerous investigations and trials, it was determined to fix on the objective of extruding a paste of the component salts. This finally provided the satisfactory solution of the problem.

New Process Developed

This process consists of four distinct steps forming in sequence a straight line complete process. These are:

1. Formation of the paste.
2. Extrusion into uniform diameter sections.
3. Drying of the extruded sections.
4. Sizing of dried sections into uniform lengths.

While the development was primarily chemical, it reached a point where mechanical research was essential to bring it to an economical conclusion. In the first two steps, a very difficult barrier was encountered, involving a definite physical chemical property which none of the research workers had previously noted either in experience or literature. It comprises the critical pressure under which a paste of salts separates from their solutions.

Under such pressure the solution migrates completely, leaving a salt cake that is immobile under any pressure. This phenomenon demanded very accurate control of pressures in the mixing and kneading of the salt pastes to extrudable consistency. The treatment requires very limited rolling pressures, beyond which the homogeneity is destroyed by the breaking away from the solution of sections subjected to excessive pressure. Mixers with interacting blades are useless for this purpose, since the salt pastes upon reaching extrudable consistency become so tenacious as to break any cutting mechanism. The edge runner type of mill, with controlled weight of individual muller rollers, provided the solution of this step.

The paste may be made from the previously prepared salts, or directly from the separate components thereof. The processing mill in which the paste is prepared consists of a pressure-tight casing, en-

SWANN CONCENTRATED FERTILIZER

At left, drill is being filled with Swann concentrated fertilizer; at right, with ordinary commercial fertilizer. Note that while the wind raises considerable dust from the less concentrated fertilizer, the Swann fertilizer is not affected.

closing the revolving pan and muller rollers. Liquid phosphoric acid and gaseous ammonia are simultaneously introduced into this mill, either with or without the potash salts. Chemical combination, fine grinding, and subsequent kneading to extrudable consistency may be completed in forty minutes.

Great Variety Possible

Many combinations of reactions may be very economically carried out in this newly developed apparatus. Both heating and cooling provision is had for the reacting materials. Provision is made for evaporating any desired amount of water, or for actually distilling NH_3 from aqua ammonia by utilizing the heat of reaction of its combination with the phosphoric acid. This mill operates in any appropriate range of pressure or vacuum.

The extrusion step involved the greatest difficulty in its mechanical development and was finally solved with great simplicity. The above described critical pressure characteristic is a vital factor in the extrusion of salt pastes. While extrusion equipment and operations are developed to a high state of efficiency in other arts, they have been confined to true plastics which have mobility under wide ranges of pressure and temperature. Extrusion specialists were consulted as to ways

of extruding these salt pastes, and decided they could not be extruded. The research workers did not know extrusion was impossible, and did it before they received the negative advice.

After the possibility had been demonstrated, a long and tedious campaign of mechanical research was required to develop equipment with which the extrusion could be carried out with economic limitations of control. The primary factor of control lies in the relation of the screw terminus to the aperture plate, such that the final extrusion pressure is developed simultaneously with paste entering the apertures. Having obtained in design the exact combination of pitch, form of terminus, relation to perforated plate, and feed, the control in this step is automatic.

The size of particle, selected with the advice of several experiment station directors, was $^{5}/_{64}$-inch diameter. The paste is extruded into long sections which are cooled instantly to harden them sufficiently to withstand the subsequent drying operation.

The extruded sections are dried by conventional means with air heated to lower its relative humidity. About eight hours are required to lower the water content below three quarters of one per cent. This drying operation produces simultaneously a density of surface greater than the interior, and likewise a highly polished smooth finish on each cylindrical particle. The water content of the wet extrudes, of course, forms a saturated solution which must migrate to the surface, where the water is evaporated as such, leaving the salts from which it evaporated filling the microscopic interstices, thus providing greater density. The surfaces are polished, removing all microscopic crystal protrusions, by the rolling action through the drier. This produces a minimum area of surface for retention of hygroscopic moisture, and thus minimizes the caking tendency.

The extruded sections emerge from the drier in lengths from $^{1}/_{4}$ inch to $^{3}/_{4}$ inch. Sizing equipment consists of two highly special devices, a multiple screen and cutting roll operating in continuous closed circuit. Both were developed entirely by the Swann organization, as in the case of the processing mill and extruder. The screen comprises a series of units having extremely low but effective magnitude of vibration. This detail of operation separates particles having the same diameter with varying lengths.

The cutting roll represents an entirely new development in mechanics. It consists of a pair of rolls, the lower having longitudinal intersecting grooves on its surface, just fitting the sections, and the upper roll having transverse grooves of duplicate contour to those on the lower roll.

The combination of co-acting edges and grooves cuts the extruded sections into exact lengths.

The New Fertilizer

The product consists of particles of uniform shape, size, and analysis. It is absolutely non-segregable as to constituents, non-caking under any normal handling and storage conditions, accurately drillable, and entirely free from dust.

About 75,000 lbs. were made in 1931, all of which was donated for field tests under the direction of extension service officials or trained agronomists. These tests were conducted in twenty different states. Several hundred reports received to date are highly favorable, testifying to accurate drillability and economy of handling and to excellent growth and yield results. Substantially all tests have been conducted in parallel comparison with equal quantities of plant food in regular fertilizers. In no case has there been any injury to germination or evidence of toxicity.

One factor in the objective consists of obtaining equally effective fertilization with application of less plant food, through more efficient placement.

The rates produced for field tests were:

N	P_2O_5	K_2O	*Total*
13	34	20	67
17	34	17	68
13	26	26	65
10.5	21	32	63.5
14	42	14	70
7.5	39	20.5	67
21	53	0	74

In addition to the above ratios, made in quantity for field tests, several hundred ratios have been made which establish the practicability of making any ratios desired in this uniform shape, size, and analysis.

The criticism of the omission of lime and magnesia in the field test lots has been made. Where really desirable, any of the other plant nutrient elements may be readily incorporated. However, consideration must be given to the economic interests of the ultimate consumer, the farmer. The need of lime and magnesia in certain soils and crops is undisputed, but the logical question is how the farmer can obtain this lime or magnesia and apply it to his soil most effectively.

Lime producers prepare and sell directly to the farmer any desired form of the carbonate, hydrate, or oxide. The farmer can certainly obtain his lime at lower cost by purchasing it directly than through the accumulative expensive route of prepared fertilizers. Each soil and crop that requires lime demands a certain quantity and form. If supplied through fertilizers, the lime needs will be supplied haphazardly instead of under needed control. Where the lime is not needed, its incorporation into the fertilizer places an unnecessary burden of cost on the farmer. It therefore appears that insistence upon lime in the really highly concentrated fertilizer defeats the economic objective and constitutes an economic fallacy.

SIX-FOOT PAN MILL

The new product appears to be an advanced step toward the objective set forth; and it is an example of the coordination of the work of the chemists in the various industries involved. Development of a unit form for any and all ratios provides the soil chemists with a constant physical state whereby they can better treat with other variables. It appears to be a definite contribution toward lowering the cost of effective fertilization.

Gregory Paul Baxter, Quantitative Analyst

By Howard Warner Starkweather

The story of the greatest living analyst. A brilliant research chemist who is also an inspiring teacher.

FOR most of us atomic weights are numbers which can be found in any chemical handbook, when we have occasion to use them. We assume that since they are in the handbooks they must be correct; and perhaps we do not greatly consider the years of painstaking work that are required to insure each number being as nearly accurate as possible, or that these numbers are being continually revised as new methods are devised or improved apparatus and technique are applied to older methods. Each year the Committee on Atomic Weights of the International Union of Chemistry reviews the determinations reported during the preceding year and publishes the official atomic weights. Professor Baxter is the chairman of this committee and the sole representative of the English-speaking countries.

Gregory Paul Baxter was born in Somerville, Massachusetts, on March 3, 1876. All of his life, save for three years immediately following his graduate work, and a sabbatical leave in Europe, have been spent within the shadow of Harvard. His father, George Lewis Baxter, was one of the leading public school educators of New England, and Dr. Baxter was early familiar with the best of the New England educational traditions. He received his A.B. from Harvard in 1896, his A.M. in 1897,

and his Ph.D. in 1899. In 1929 the University of Michigan granted him an honorary Sc.D. During his senior year in college and his first year in graduate school he was an assistant in chemistry. For the next two years he was an instructor. In 1899–1900 he gave the chemistry courses at Haverford College during the absence of Professor Lyman B. Hall. For the next two years he was assistant professor at Swarthmore. He then returned to Harvard as instructor. From 1905 to 1915 he was assistant professor, from 1915 to 1925 he was professor of chemistry, and since 1925 has been Theodore William Richards Professor.

SINCE his first publication with Professor Richards in 1897, "A Revision of the Atomic Weight of Cobalt," Dr. Baxter has been consistently publishing reports of investigations which have maintained and advanced the high standard of the "Harvard methods" as developed by Cooke and by Richards. This first paper was the report of part of an investigation of the then debatable atomic weights of cobalt and nickel in relation to their positions in the periodic table.

In his determinations of atomic weights Dr. Baxter's attention has been concentrated on those which were debatable or were of fundamental importance in relation to other atomic weights. Either with his own hands or with the aid of assistants he has already determined the atomic weights of twenty-six elements. In all of his work it might as truly be said of him as he said of Professor Richards: He possesses "an infinite capacity for taking pains, an uncompromising attitude toward the possibilities of hidden errors, a determination to be certain that no precaution has been overlooked, an extraordinary persistence in the patient repetition of exacting and laborious experiments, combined with unusual manual dexterity and ingenuity."

In his laboratory all possible methods of purification have been employed to insure the purity of the compounds used. In the investigation of neodymium 2945 different crystallizations were made, and in determining the atomic weight of praseodymium 4383 crystallizations of praseodymium ammonium nitrate were made before the praseodymium was converted to the chloride.

In more recent investigations, which have involved purification of inorganic volatile salts by fractional distillation in high vacuum, it has been the usual practice to carry out thirty distillations, removing a light and heavy fraction with each distillation, this with material which ordinarily would be considered reasonably pure at the start.

In all of this work the purity of the material is followed by spectroscopic examination or by other suitable tests. It is essential in under-

taking an investigation of this character to select a salt which can be prepared in the desired state of purity and can be analyzed with the requisite accuracy. Professor Baxter has an uncanny sense in selecting the proper compounds.

Many of the determinations have involved the preparation of metal halides and precipitation of the halide with silver, with a nephelometric determination of the end point. In other cases, as with arsenate, chromate, and phosphate the silver salts have been prepared and the silver precipitated as the halide. In the case of iron the metal oxide-metal ratio has been determined. Several researches have involved the electrolytic determination of the metal in a suitable salt. Still more recently there have been several determinations of the limiting densities of gases. In addition to measurements of their densities under standard conditions this has involved determinations of their compressibilities at low pressures in order that the atomic weights might be corrected for deviations of the gases from ideal. Attempts are continually being made to improve methods to give as many checks and cross references as possible.

Professor Baxter is a firm believer that the modern methods used by the physicists in studying isotopes do not obviate the necessity of continuing chemical investigations of atomic weights but makes them even more important and interesting. He believes their fundamental importance has been increased rather than diminished.

In order to establish the universality of any given atomic weight, materials from widely different sources have been investigated. This has included the separation of elements from several different meteorites, as well as from different parts of the earth's crust. The atomic weights of samples of lead of known radioactive origin have been determined as part of the program of the Committee on the Age of the Earth of the National Academy of Science.

PROFESSOR Baxter's chemical interests have by no means been confined to the determination of atomic weights. He has published papers on the occlusion of gases by metals and the carrying down of soluble salts by precipitates. He has improved several fundamental analytical methods, such as the determinations of carbonates, iron, oxalic acid, phosphoric acid, and potassium. The solubilities of certain inorganic salts have been determined. Measurements of refractive indices have been reported. The vapor pressure of several substances and the aqueous pressure of hydrated salts and of drying agents have been measured. A series of investigations has dealt with the change in volume of salts upon solution in water.

Professor Baxter's activities in the laboratory have not been limited to his research work. Each year he gives three courses in Harvard and one or two courses in Radcliffe. The same thoroughness he shows in the research laboratory is shown in the course laboratory and in the classroom. In the laboratory period he talks with each student, helping him to correct any difficulties he may be having with his analyses. His lectures are clear, definite, straightforward, and complete. Students do not go to sleep during his lectures. They count him one of the best.

From 1912 to 1931 he was chairman of the department of chemistry. For years he was on the Administrative Board of Harvard College.

SEEMINGLY, it would be impossible for Professor Baxter to accomplish the tremendous amount of work he does were it not for a native wisdom in making the most of his holiday periods. He has a feeling for, and experience in, the New England countryside. For years a point on the Maine coast has been his destination in many a hurried departure from Coolidge Laboratory, if even the briefest lull in the work gave opportunity. He is an expert and devoted sailor. That is why one finds him, on his return, a man ruddy from ocean winds, freshly competent to apply himself to the confining, meticulous investigations he has chosen for his life's work.

Mass Meeting

A MEETING of the New York sections of the principal chemical and chemical engineering societies was held in the Engineering Societies' Auditorium on Friday, March 4th, to consider the problem of unemployment in the chemical profession. The movement for the meeting was inaugurated by a Volunteer Committee, with Frank G. Breyer as executive secretary.

With George C. Lewis, president of The Chemists' Club, as chairman, the 400 chemists and chemical engineers present listened to addresses by a number of speakers, including Edward R. Weidlein, Daniel D. Jackson, and Charles H. Herty. The following resolutions were then adopted:

WHEREAS it is estimated that from 15% to 20% of all chemists and chemical engineers in the metropolitan district are at present unemployed, and

WHEREAS immediate and united action is required to prevent the situation from becoming even more serious and adversely affecting the interests of all chemists and chemical engineers, and

WHEREAS it is evident that if the united support of the whole profession is behind a single continuously operating agency, work will be found more quickly for those who are unemployed, and much that would otherwise be impossible can be done for individuals in need of help, and a fairer proportion of legislative and public aid funds can be obtained for chemists and chemical engineers in want, and

WHEREAS effective handling of the present emergency will do more than anything else possible to preserve and increase the prestige of the profession,

Be It Resolved That all chemical and chemical engineering societies in the metropolitan district be urged to recognize the seriousness of the emergency and to take action by:

1. Appropriating as much as possible from present funds to keep the present work going and make possible an effective central organization.
2. Appointing a representative to the central committee to help organize a campaign for funds and to assist in planning and carrying forward constructive work in finding jobs for chemists and chemical engineers.
3. Appointing a committee to work among its own members to develop financial and moral support for the work of the central committee, to the end that each member of the profession may realize the importance to himself of aiding in every way possible in placing unemployed chemists and chemical engineers.

And Be It Further Resolved That the secretary of this meeting is instructed to forward a copy of these resolutions to all chemical and chemical engineering societies in the metropolitan district.

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The addresses delivered will be reported in the next issue of *The* CHEMIST.

BY-PRODUCTS

George Washington

THE American people are appropriately dedicating this year to George Washington, and undoubtedly before the twelvemonth is completed we shall have dissertations, discussions, addresses, essays, and expositions on every phase of his life, attainments, and great abilities. We hope, but with small expectation that it will be realized, that some competent philosophical historian will reveal to us just what quality or combination of qualities this very unique American possessed that will explain his extraordinary career.

From early youth he was a distinguished figure in a society that did not lack men of eminence. Heavy responsibilities were entrusted to him even before he was out of his teens. The whole country unanimously nominated him to the command of its armies at the outbreak of the Revolution, when he was but 43.

What manner of man was this who challenged the admiration and compelled the respect of all who approached him? He was not a great military genius in the sense that Napoleon, Caesar, and Alexander were. Undoubtedly there were many soldiers in the colonies—General Lee is an example—more deeply versed in military science than he. Nor was he a great statesman like Jefferson, Madison, Jay, and Adams, though he was a thorough student of statecraft. His legal knowledge was only that sufficient for the needs of a gentleman farmer. His administrative abilities appear to have been average.

But he could win men; he converted enemies into devoted friends. His officers wept unashamedly on the occasion of parting with him in Fraunces Tavern. Men like Von Steuben who at first held him in little esteem came, as they knew him better, to follow him without hesitation. Among the associates of Washington familiarity did not breed contempt but reverence. Longer acquaintance led to greater respect. Is this not in itself remarkable?

He was the target of many bitter and often scurrilous attacks; a tragedy was successfully performed in France in which Washington appears as the murderous villain. But these attacks were made by men who never knew him. No one turned from him to become an enemy. Even the English people, who might excusably have been

unfairly hostile, entertained for him the highest regard, as is abundantly demonstrated by contemporary writings.

We have long sought a satisfactory explanation of this phenomenon. Perusal of the encomiums of generations of historians, essayists, July 4th orators, and the like fails to discover an acceptable theory. Our own conclusion is that Washington is to be understood by reflection on his qualities of pure manhood. If Napoleon did say of Goethe, "Voila un homme!" what might he have said had he known Washington?

Television

Our old friend Dr. Wiley, peace to his ashes, had a mid-Victorian devotion to classical culture, now, alas, reduced to the bosoms of a few pious valetudinarians who still keep faith with Homer and Virgil. This devotion led him on various occasions to denounce the word television as a barbarous mixing of Latin and Greek roots. He argued for a pure Greek term and suggested "teloptiky." This term, however, is too full of knots to be widely accepted and put into parlance. After due consideration we hit upon the form "telopsis," which is unobjectionable either on classical or on lingual grounds. But we are aware that, having already had movies and talkies, we are quite likely to have lookies, glimpsies, or seegies.

Vitamin Verses

"DR. STEENBOCK plans to add vitamin D to cow's milk by feeding Bossy irradiated yeast."

This statement was the gist of a report in the daily press. It provoked the following:

Doctor Steenbock, skillful man,
Has evolved a clever plan
To feed the female bovine beast
A daily dose of sun-kissed yeast.
Cows will now be better bred,
And infant calves be richer fed.
Now we can surreptitiously
Feed our brats vitamin D,
And never dispositions spoil
With fish-taste of cod liver oil

But what will Josh and Hiram say
About this latest-fangled hay
When Prohi agents sniff the barm
That saturates the dairy farm?
Will yeast and glucose in the rumen
Interact and start things boomin'
And docile bossy act like sin
As if she poisoned were with gin?
'Pears like placid scenes bucolic
May yet wear aspect alcoholic.

This poet will be safe at least,
He shuns the milk and hates the yeast!

Personal Prestige

SEVERAL years ago the baseball club that took its name from the town in which we were at the time domiciled won the pennant of one of the major leagues for the first time. As the end of the playing season approached and it became apparent that "our" team might, in technical language, "cop the canvas," excitement surged in every breast, and half a million pulse rates accelerated daily to newer and higher counts. Staid merchants of hitherto irreproachable habits suddenly became diamond-conscious; dignified lawyers sniffed the virus in the air and became infected; elderly, austere ladies began to let bits of home-plate slang mingle with their meticulously exact English. Spiritual ecclesiastics, ponderous professional men, even erudite professors stirred sluggishly to the ubiquitous innoculum.

As day succeeded day and the team held its advantage, the agitation of the burghers issuing from the mêlée of contending hopes and fears grew to an incredible extent; and when finally the deciding game was, as the phrase is, "in the bag," the repressed passions of the populace exploded in a celebration that dwarfed anything the town had previously known. Stores, factories, offices, and (we doubt not) churches closed and disgorged their human contingents into the brimming streets, where a pandemonium of roistering revelry hourly became more vociferous and vicious. Everyone was superlatively happy including the sober and scholarly gentleman who chronicles the event.

But being cursed with an inquiring mind and a most vicious weakness for trying to understand the underlying causes for events, the chronicler was vaguely disturbed in his emotional enjoyment by the intrusion of the rational faculty, asking "Why?"

"What does all this celebrating really mean?" "Why do otherwise moderately rational people suddenly become so overjoyed at an event that, after all, is due to no activity of their own and cannot confer any real benefit?" "Why should a town suddenly erupt blissfully over the achievement of a team no one of whose members owes the town any native allegiance and who may next year be representing a rival club?"

The answer was not immediately forthcoming, but, being highly interested, we pursued the subject, erecting successive working hypotheses, testing, and then discarding them. Finally it occurred to us that the reason is the same as that which makes one proud to claim birth in a respected place, or into a respected race; that makes one boast of connection with a famous institution or powerful organization; that underlies a certain type of patriotism known as nationalism; that makes social success, dignified office, and membership in exclusive clubs desirable; that plunges the alumnus into the depths of suicidal despair when his college football team loses an important game!

Personal prestige. *In dies ultra miser!*

—*The Autocratic Chemist*

CONTEMPORARY THOUGHTS

Now We Know Earnings—What Next?

A.S.M.E. committee on the economic status of engineers plans action. What another profession is doing. Reprinted from *Mechanical Engineering*.

THE task given the Committee on the Economic Status of Mechanical Engineers, on its appointment in May, 1928, was to determine the engineer's economic status and to make suggestions for its improvement. The Committee soon saw that the problem was more inclusive than earnings alone, and that it also involved the professional and social status of the engineer.

The first job of the Committee was a study of earnings. This job has been done. Through the cooperation of over 9000 members and of the Local Sections, exceptionally accurate information as to the earn-

ings and professional status of mechanical engineers has been obtained. From the start, however, the Committee was determined that this investigation should lead to positive action and not be "just another questionnaire." At the Annual Meeting it announced the following plans to put this information to work.

The most valuable use that can be made of this material is, of course, by the individual engineer. To make it available to him in such a way that he can reach his own conclusions, articles consisting primarily of charts were published in the September, November, and December issues of *Mechanical Engineering*. By turning to the appropriate chart, any engineer who is interested can readily discover what are the normal earning levels at all ages, in his locality, in his industry, in his type of work, or for a man of his type of education; and so can make his decisions on the basis of facts. To a considerable extent he can also determine the aspects of his work which it is most important for him to emphasize in order to develop himself professionally.

In order to bring this material together in a single unit for distribution, the Committee is now publishing the three articles in a single report. It has also prepared complete sets of slides for use by the Local Sections in bringing these findings before their members for frank discussion of their significance.

Besides putting this material in the hands of members, the Committee plans to see that it reaches those people responsible for action. The report is being sent to deans of engineering schools and to engineering, management, and similar associations. In addition, wherever the report indicates a condition calling for remedial action, the specific situation is being brought to the attention of those concerned. Thus, the report is being sent to influential organizations in those localities and in those industries where engineering salaries fall seriously below the general standards of the profession. With it a letter is being sent which points out the particular condition and seeks to make clear that, apart from some modifying circumstance, if these localities and these industries desire to secure the best engineering talent, they must pay the "going rate" of the profession. Similar action will be taken to see that persons in influential positions in leading companies realize the extent to which branches of engineering, such as research and design, which are underpaid in proportion to general professional standards, must be paid a higher rate if the best engineering brains are to be attracted into this vital creative work.

Perhaps the greatest significance of the study is the indication it gives

that, regardless of his specialty, the mechanical engineer can rarely rise to his full stature in his profession unless he is a "man of full habit." Whether he be an executive, or a creative designer, his chances of attaining the higher positions in his profession are small unless he is both a man of technical talent and a man whose fullness of mind and heart give him a capacity for leadership among his fellows. The Committee believes that the Society has an important responsibility for bringing about the realization by the profession of this well-rounded conception of the engineer, and of attracting into the profession young men qualified to attain it.

The Committee plans to start at the bottom in seeking to do this. They plan to help boys who are considering becoming mechanical engineers to decide whether or not to enter the profession. To this end the Committee is preparing an article for distribution in preparatory and high schools, which will outline the general scope and activities of mechanical engineers and emphasize the type of preparation and the qualities that contribute to professional success. Because of the information secured through the survey, the Committee is able to give definite facts rather than vague opinions. It is, for example, able to say with conviction that:

1. A good professional education distinctly pays.
2. Success is largely won in the first fifteen or twenty years of professional work. It depends upon the extent to which technical skill is combined with hard work, clear thinking, and capacity to learn from experience in developing the "graduate" into a professional man of large stature.
3. An engineering training offers little to men of mediocre abilities, but provides a great opportunity for men of outstanding qualifications.
4. A substantial majority of all but the youngest mechanical engineers occupy executive positions, either as heads of technical work or as general executives. Engineering is thus a pathway to executive opportunity.
5. Even in its more technical branches, mechanical engineering calls for men who are professional in their capacity to deal with the human as well as with the material factors of industry.

Similar information will be provided for colleges. For young engineers at work the Committee plans to work with the Local Sections. Not only will it provide the Sections with data, but it will work with them in seeking to broaden and enrich the experience of the young engineer.

It will seek to assist the Sections to stimulate post-college training and activities, such as discussion groups. It will seek to assist them to bring into the local meetings a broader point of view and a relation to the civic and cultural life of the community.

A final step is to bring about the certification of engineers on a basis of combined technical, creative, and executive qualifications. In this work especially, but also in carrying out most of its other plans, the Committee proposes to work as far as possible with the other engineering societies. Clearly, this is a matter for the entire profession. Fortunately, other societies are appointing committees, and we are sure of wholehearted cooperation from them. Our Committee, in conference with committees from the other engineering societies, has already recommended to the Council a definite program of joint action.

Throughout, the Committee realizes the value of the highly trained creative engineer upon whom society depends for the technical advances which are fundamental to civilization. The Committee does not want to make an executive out of him. It does want, however, to bring more executives into the profession, and at the same time to support the splendid work of the creative technician by assisting him to develop that full life which marks the professional man.

It is with this purpose and through these means that the Committee is seeking to make its survey more than a matter of passing interest—a source of positive development in the Society and the profession. In all its work the Committee is placed in a much stronger position due to its investigation. In its contact with members and sections, in its work with schoolboys, professional students, and young professional men, the investigation has enabled it to act largely on the basis of objective information and not on unsupported intuition. The Committee realizes, however, that whatever results are obtained depend primarily on what the individual engineer and the Local Sections do. It solicits their active interest and help in constituting the survey, in which they cooperated so generously, a positive step forward for the mechanical engineer.

What's in a Name?

By Stewart J. Lloyd

Justification of courses of action or study simply by the names they bear. The importance of certain factors in chemical education.

PRESIDENT ROOSEVELT used to tell with much gusto the story of his settlement of the great anthracite strike of 1902. The mine operators objected to the inclusion of any labor leader in the committee appointed to negotiate a compromise, but they were willing to accept the appointment of a "distinguished economist." The men on the other hand demanded that Mr. X, their leader, be taken in, and a deadlock ensued. The redoubtable Rough Rider solved the difficulty in a characteristic way, by nominating Mr. X, but designating him as a distinguished economist instead of a labor leader, and everyone was happy.

Some years ago a geologist had occasion to report on the foundation for a proposed hydroelectric power dam, and described in so doing a thoroughly sound rock in the foundation as a quartz-hornblende schist. The report promptly came back with the comment that one of the bankers who were to finance the project objected to a schist in the foundation and he understood that it was a very weak fissile rock, like a shale. The report was straightway amended by calling the foundation a "quartz-hornblende rock," and again everyone was happy.

Is Ceramics Chemistry?

Still more recently, and this brings us to the real subject of this little article, the writer was taken to task by the authorities of a certain university for allowing a student majoring in chemistry to include a course in ceramics as part of that major.

The objection was met by changing slightly the name, not the content, of the course in question, calling it "The Chemistry of the Silicates," and once again everyone was happy.

These incidents well illustrate how easily we are led astray by names, and how subjects which are closely allied in purpose and in content can remain widely separated, sometimes even in the minds of those quite familiar with them, because of the name we use. It was the realization

of this fact that led a few years ago to the establishment at the University of Alabama of a School of Chemistry, Metallurgy, and Ceramics, distinct from chemical engineering and metallurgical engineering and intended to emphasize the close association of these three related sciences, with chemistry as the cornerstone.

Narrow Chemists

It is astonishing how specialized and narrow the education of some of our chemists is becoming. I recall an associate who received a Ph.D. in chemistry some years ago from a prominent university, but who did not know that the gravel he walked over daily to class was silica, and expressed surprise when so informed. His major work was in organic chemistry. This is paralleled by the remarks of another Ph.D. in physical chemistry, who when told that a ceramics department had been authorized, said that he did not think it the duty of a university to teach china painting.

Quite as enlightening were the expressions of dismay from the metallurgists and ore dressers when organic materials like alpha naphthylamine began to find extended use in flotation.

Here at the University of Alabama we have established a precedent to the effect that no student may carry away a degree in chemistry without having somewhat more than an elementary knowledge of chemistry applied to metals (metallurgy), and chemistry applied to silicates (ceramics). Nor do we allow a student specializing in metallurgy to avoid a considerable knowledge of ceramics, and vice versa, and neither of them may ignore entirely the vast field, ever extending of biochemistry.

It is very probable that there is already a sufficient number of schools of ceramics in America, schools in which ceramics is taught as an end, to students intending to practice the art upon graduation. There may indeed be too many. The same is probably true of metallurgy or the combination of mining and metallurgy which linked together by ore dressing belonging to neither, is so frequently encountered. In the writer's opinion, however, courses in ceramics and metallurgy are an essential and integral part of a training in chemistry, and no school or department can give adequate instruction without including the elements of these two subjects, taught by competent men.

Another brand of chemistry in which nomenclature has caused much mental anguish brings us to the other extreme from the minerals, to the living plant and animal. What is the difference between physiological chemistry and biochemistry? This problem exercised the mind of a

university president suddenly called upon to assume the responsibility of operating a medical school, and being a self-reliant individual he appointed, without consulting anyone, a professor of each subject. It is not on record how they divided up their common field.

Precision in the use of words is becoming a lost art, and here again the scientist and the textbook of natural science are the chief offenders. One of the difficulties encountered is to get the student to believe, especially where examination papers are concerned, that "state, describe, discuss, explain, sketch" and so forth, actually have different meanings. Especially notorious is the abuse of the word "explain." One of my treasures is an examination paper in history put together, be it said, by a young instructor, which contains this gem among others, "Explain Mary, Queen of Scots." The student who could answer that question should assume Shakespeare's crown as the interpreter of the human heart.

A very distinguished physicist once said that on examining physics textbooks he had found their worth to be rather closely proportional, inversely of course, to the frequency with which they used the word "explain."

Language Still Essential

This article started off to justify the inclusion of chemistry, metallurgy, and ceramics in one school under one roof, and has wandered away into a disquisition on the use of words.

The use of language, however, is still the chief distinguishing mark between man and beast, and the ability to use it with precision, force, and with an accurate knowledge of the differences in the meanings of words, so that each word appeals to the listener or reader as the only possible one for the place—this is really the mark of an educated man quite as much as the ability to read with feet on the fender Plato in the original. Very often, however, the two go together.

Chemistry at Western Reserve

By Olin F. Tower

The development of the chemistry department at a typical mid-western university.

WHAT is now Western Reserve University started at Hudson, Ohio, twenty-five miles south of Cleveland in 1826 under the name of Western Reserve College. No special courses in chemistry were taught in the early days. What little information was imparted in this science was included in a general course of Natural Philosophy. In 1869 Edward W. Morley was called to the college as professor of natural history and chemistry, and from this time on chemistry was a required subject in the curriculum.

Professor Morley was a graduate of Williams College, 1860, and afterward studied for the ministry. But at Williams his natural aptitude for exact scientific measurements had appeared. While there he made the first accurate determination of the latitude of the Williams College observatory, which was later published in an article in the Transactions of the American Association for the Advancement of Science.

During his first year at Western Reserve he had a room in one of the college buildings fitted up as a chemical laboratory and, as one of the early catalogues states, had "the class perform under the guidance of the professor all those experiments which are suitable for them. Those which demand more experience will be performed for the class by the teacher." This course in general chemistry was required of all candidates for a B.A. degree, and those who so desired could also elect a course in quantitative analysis. This was the extent of the chemical

curriculum until the institution was moved to Cleveland in 1882. In 1885 a course in organic chemistry was added.

Professor Morley was a great teacher and a great experimenter. He possessed remarkable ability for making exact measurements, and while at Hudson constructed an apparatus by which he could measure the oxygen content of the atmosphere. He carried out measurements of this quantity over a period of years to try to ascertain the effect of the weather on the variation of the oxygen content of the air. Shortly after coming to Cleveland he joined with Professor Michelson in making those elaborate experiments on the drift of the ether, which have since attracted so much attention. The work, however, for which he is best remembered by chemists was on the determination of the ratio in which oxygen and hydrogen combine to form water, which is mentioned in nearly every textbook on general chemistry.

E. W. Morley

This research occupied his time for eleven years, a period during which he was also carrying his full load of teaching.

At times the total of his tasks became rather large. The chemical laboratory was on the top floor of the main building. Professor Morley was carrying on his research in the basement, so that he became interested in finding out how far he traveled in the course of a day. By the use of a pedometer he estimated that he traveled eighteen miles every day in going back and forth from his research to his classes.

Later Developments

In 1895 the first addition was made to the staff, and since that time the department has grown rapidly. The writer came here in 1898. The following year courses in physical chemistry and the chemistry of food and nutrition were introduced.

Professor Morley retired in 1906, leaving to the department one of the best libraries of chemical periodicals in the middle west. He also had completed plans for a new chemical laboratory. This laboratory, called the Morley Chemical Laboratory, was completed in 1910 and housed also the department of geology. In 1924 the latter department was compelled to move out to make room for the growing needs of chemistry. Since then practically the whole floor of another building

MORLEY CHEMISTRY LABORATORY

has been taken over and fitted up with research rooms for students in physical and organic chemistry, and also with a large room for quantitative analysis.

Undergraduate Courses

Western Reserve is not one of the larger universities, there being only about 1800 undergraduates. There are no courses in chemical engineering, as this work is carried on at Case School of Applied Science on the adjoining campus. Furthermore, we have a coordinated system of education, with separate colleges for the men and the women, the former known as Adelbert College and the latter as Flora Stone Mather College. To save the duplication of laboratories the work in the natural sciences is carried on in joint departments, but the sexes are in separate classes for the most part during the freshman and sophomore years.

Two courses in general chemistry are given in each college, one for beginners and the other for those who present chemistry for admission. The latter is devoted almost entirely to chemical theory and its applications to the simpler classes of chemical phenomena. A general informational and cultural course for those not desiring to continue chemistry has not attracted sufficient students in the men's college to make it worth while. However, Chemistry 1 in the Flora Stone

Mather College is of this nature, as a large majority of the women do not wish to specialize in the subject. A separate division of the class is conducted in the second semester for those desiring to go on with chemistry.

Students desiring to major in chemistry must complete in addition to their freshman work, one year of organic chemistry, one year of quantitative analysis, one semester of physical chemistry, and one other elective course for one semester. Courses are given in chemical microanalysis and in the chemistry of food and nutrition.

Graduate Courses

The graduate school is young, having had its real beginning only in 1925. In 1928 the first Ph.D. degree in chemistry was given. Since then the graduate work has grown rapidly and this is now one of the largest of the graduate departments in the university.

Excellent facilities are provided for research in catalysis, general physical chemistry, organic chemistry, and inorganic chemistry, especial attention being given to the compounds of fluorine. In addition there are a few students working in the fields of colloid chemistry and nutrition. All work in biochemistry is done at the Medical School of Western Reserve University, where a new building provides ample facilities for graduate work in this field.

WHY I CHOSE CHEMISTRY

Evolving Experimenter

By T. A. Wright

TO LOOK back thirty odd years and analyze the reasons for a particular decision is rather difficult if one is to avoid letting hindsight color one's views. The reasons for the decision to follow chemistry as a profession are perhaps no more mixed, however, in the case of the writer than with most others.

If ever a boy is interested in the new, it is at the age of eleven to fifteen. I was introduced to elementary physics at thirteen and elementary chemistry at fourteen by a born teacher—a woman by the

way—who taught principles, not statistics or figures. It seemed quite obvious that here was a chance to go through life blithely flitting from experiment to experiment with a new color here, a new odor there. What boy doesn't like to experiment? To one boy, chemistry at that period seemed all adventure; and I knew a chemist who made $90.00 a month. What wealth!

So, by wheedling the teacher, I made arrangements to obtain an extra year of qualitative chemistry, in exchange for help with the regular laboratory work. This opened opportunities for further experiments and adventure in science (shall we say) and further cemented my ambition to be a chemist. One experiment, involving the distance H_2S would travel, exceeded the modest expectations of giving the German teacher in the next room something to think about. As the laboratory was on the third floor, and the gas cleaned out even the first, I proved that H_2S was heavier than air. The experiment was very successful. The students, among whom by good luck was the writer, came back the next day.

ON COMPLETION of this high school course, the need arose for a job, although laboratories were not so common. A chance came to work as a clerk in a fertilizer office, above which was a laboratory. Two years of plant and laboratory smells only added to my urge to be a chemist; and the end of this period found an opening at last to start on that career.

The basis for such a choice, however, goes back to the influence of a father who insisted on the one hand that no son of his should ever work in a foundry and who also looked with scorn on white collar office workers. Quite naturally such a father would elect an academic or scientific course rather than a commercial one for a young son entering high school.

Finally, an industrial environment, consisting largely of fertilizer, copper, and chemical works even in 1900, no doubt had its part.

BOOK REVIEWS

Introduction to Biochemistry. By ROGER J. WILLIAMS. *D. Van Nostrand.* $4.00.

In his preface, Dr. Williams says, "The 'organic chemistry' of a hundred years ago dealt with the chemistry of organic life, but today it deals with carbon compounds, the majority of which have no relation to the chemistry of living processes." Hence, in the text before us, the author has written in considerable detail of that enormous field which has grown into bloom at the side of and yet out of the consciousness of many of us. While the text is primarily designed for the orientation of undergraduates with only a fair training in other branches of chemistry, that aspect is not of particular concern to this reviewer.

His interest arises from the fact that the book is admirably adapted to fill some of the lacunae existing in his own as well as possibly in the minds of many of his professional brethren. The time is long past when a Leonardo da Vinci could be at the van of all the science of his day or even when a Berzelius could span the universe of chemistry. So it behooves us of the present day to be grateful to the men who, like Dr. Williams, compress into a readable volume one whole branch of our science.

The following quotation is cited to show the vast possibilities open in biochemistry and at the same time the reasonableness of the infinite diversity of living things: "—in a particle the size of an ordinary yeast cell there would be room for about half a billion molecules each with a molecular weight of 100,000."

The *Introduction to Biochemistry* is well written, stimulating, conservative in statement, and contains after each chapter a few suggested readings for those who wish to pursue any branch more thoroughly.

KARL M. HERSTEIN

Manual of Industrial Chemistry. By ALLEN ROGERS. 2 vols. *D. Van Nostrand.* $13.00.

Each successive edition of this well-known work has brought it nearer to the literal fulfillment of its title. The fifth edition, now at hand, has fifty-two chapters. A number of them bear no author's name and

presumably come from the pen of Dr. Rogers. The balance of the chapters have been contributed by various authors. The authoritativeness of the latter and the scope of the work will be indicated by the mention of some of the chapters: Soap and Soap Products by M. H. Ittner, City and Industrial Gases by W. H. Fulweiler, Water for Industrial Use by D. D. Jackson and W. D. Turner, Sulphuric Acid by W. M. Grosvenor, and Lime, Cement, and Plaster by the late Richard K. Meade.

The processes of natural growth and revision to bring it up to date have diminished somewhat the value of the *Manual* as a textbook; but this has been more than compensated by its increased usefulness as a descriptive reference on industrial chemistry and by its interest as a reading on the present state of the art in much the greatest portion of chemical industry.

In view of this alteration in the applicability of the book it might have been advisable to omit the chapter sub-headings, which resemble an instruction syllabus, and to amplify the index. Despite these criticisms, the material is readily accessible and quite abundant enough to be an introduction into any of its chosen fields. Mechanically the division into two volumes has made its handling more convenient. The tabular charts in the sections on Coal-Tar Chemistry are excellent. The binding, in black fabricoid, does not do the book justice.

As always, great credit is due and by this reviewer cheerfully given to an editor who has assembled so many stars between the covers of one book.

KARL M. HERSTEIN

Industrial Chemical Calculations. By HOUGEN AND WATSON. *John Wiley and Sons.* $4.50.

Professors Hougen and Watson of the department of chemical engineering at the University of Wisconsin have written this text to fill the gap between the college courses in physics and the need of the chemical engineer for thorough knowledge of the application of physical principles to his industrial problems.

That is not to say that this is a textbook of physical chemistry or that it is designed to replace the study of physical chemistry. The topics treated cover broadly the field of chemical engineering, and the numerous graded problems are all of a practical trend. Theory is not slighted but is made very much the handmaiden of industry. The book should prove a valuable addition to the texts in any thorough course in chemical or metallurgical engineering. H. M. T.

OUR AUTHORS

Business and Chemistry

David P. Morgan, Jr., F.A.I.C., knows what he is talking about when he discusses the influence of business risks on the development of the chemical industry. His work with Scudder, Stevens, and Clark, investment counsel, brings him into close touch with the business men who eye carefully any branch of the chemical industry before they put their money into it.

A consulting chemist before he took up commercial research, Dr. Morgan knows his chemistry as well as finance. Interested also in the profession, Dr. Morgan is secretary of the New York Section of the American Chemical Society. He is a contributing editor of *The* CHEMIST.

To Dr. Morgan's energetic publicity work goes much of the credit for the success of the recent joint meeting of nine chemical societies.

Public Health Chemist

Glenn V. Brown took his B.A. degree at Dickinson College and returned to the same institution for his M.A. degree. Continuing his graduate work at Hopkins and at the University of Pennsylvania, he received his Ph.D. from the latter institution. His work is now with the Sanitary Water Board of the State of Pennsylvania, which work he describes in his article.

Dr. Brown's article is in line with the suggestion made at a fall meeting of the New York Chapter by Dr. Benjamin T. Brooks, that the Institute go rather fully into the subject of the chemist and public health. Later we hope to print other articles describing the work of chemists in connection with the health commissions of other states.

A former member of various Institute committees, Dr. Brown is interested in the problems of the chemical profession. His hobby is bibliographies.

Expert on Fertilizers

Bethune G. Klugh, vice-president of Swann Research, Inc., was successively chief chemist, Toledo Furnace Company; general man-

ager, Southern Manganese Company; chief engineer, American Ore Reclamation Company. In addition to his mining experience he is best known for his work in phosphoric acid manufacture by electrothermal process. He is the author of patents on phosphate smelting, phosphate products and processes, and material handling equipment in this industry.

Mr. Klugh's present article is the substance of his speech before the New York Chapter of the Institute. What he modestly did not bring out in either his speech or his article is that most of the credit for the development of the new Swann fertilizer belongs to Bethune G. Klugh.

Patent Attorney

Charles W. Rivise is a chemical engineering graduate of the University of Pennsylvania, a law graduate of George Washington University. After five years in the patent office as an assistant examiner he took up the practice of patent law. He is advisory editor of *Plastics and Moulded Products* and is chairman of the patents committee of the Technical Association of the Pulp and Paper Industry.

Mr. Rivise's article is taken from his forthcoming book, "*Chemical, Electrical, and Mechanical Patents.*"

Baxter Biographer

H. W. Starkweather, Ph.D. (Harvard), can speak with authority about Dr. Baxter's atomic weight work, as he himself helped with it. He spent several years as a National Research Fellow in the Coolidge Laboratory at Harvard, making the most important atomic weight determination of all, a check on the density of oxygen.

Dr. Starkweather also determined the density of helium, using one of the few cylinders of the gas that escaped being lost with the *Shenandoah.*

In both of these determinations, Dr. Starkweather used great refinements of procedure, taking pains that would make the average analytical chemist shudder. Each weighing, for example, took an entire day, and had to be made in a thermostatted room.

Since 1929, Dr. Starkweather has been at the experimental station of the du Pont Company.

Chemistry at Western Reserve

Olin F. Tower took his B.A. and M.A. degrees at Wesleyan, his Ph.D. at the University of Leipsic. Returning to Wesleyan, he was

assistant in chemistry for three years, then transferred to Western Reserve, where he has been director of the chemical laboratories since 1907.

Dr. Tower's particular chemical interests have been research on manganese dioxide electrodes; the transport number of sulphuric acid; the method of measuring the vapor pressure of solutions; and, most recently, the Liesegang rings. A Fellow and also a Councilor of the American Association for the Advancement of Science, Dr. Tower is a member of Phi Beta Kappa and Sigma Psi, as well as of a number of American and foreign scientific societies.

Like many chemists, Dr. Tower is fond of fishing. He has a summer place on the Muskoka Lakes in Canada, where he also indulges his taste for canoeing.

Experimentalist

Thomas A. Wright, F.A.I.C., is the author of "The Consulting Chemist" in the November issue of *The* CHEMIST, in which he described this field of chemical activity from a viewpoint acquired in his association with the house of Lucius Pitkin, Inc.

Mr. Wright's chief experience has been in the management of a commercial consulting firm, though he also takes an active part in laboratory activities. His specialties are precious metals, copper, and lead.

What's in a Name?

Stewart J. Lloyd, F.A.I.C., did undergraduate work at Toronto and at McGill before going to Chicago for his Ph.D. Since 1911 he has been head of the department of chemistry at the University of Alabama. He is also a consulting chemist for the Alabama Power Co.

Perhaps because much of his chemical work has dealt with minerals, Dr. Lloyd's hobby is geology, though he has also published papers on such subjects as tribromphenolbromide. A versatile linguist, he is familiar with seven languages.

Dr. Lloyd's latest work has been to make a chemical survey of the Birmingham district for the Birmingham Industrial Board.

INSTITUTE NOTES

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National Council

The eighty-eighth meeting of the Council of The American Institute of Chemists was held at The Chemists' Club, on Thursday, February 11, 1932. President Frederick E. Breithut presided.

The following councilors and officers were present:

Messrs. Arnstein, Cayo, Crossley, Grosvenor, Harold, Herstein, Knight, Neiman, Rogers, Sachs, Zons. Mr. Edward L. Gordy, editor of *The* CHEMIST, and Dr. Lloyd Van Doren, chairman of the Committee on Constitutional Revision, were also present.

The Secretary read a letter from Colin W. Whittaker, secretary of the Washington Chapter, calling the attention of the Council to the following resolution, which was unanimously adopted at a regular meeting of the Washington Chapter held January 29, 1932:

"RESOLVED, That the Secretary be instructed to write the national office of the Institute requesting that the American Institute of Chemists express its disapproval of, and make a vigorous protest against, any reduction in the salaries of government chemists and to protest also the amendment to the Agriculture Appropriation Bill which forbids promotions during the coming fiscal year."

Upon motion made and seconded, the Secretary was directed to write a letter embodying the sentiments of the resolution, to the chairman of the Appropriation Committees of each branch of Congress, and to the floor leaders of both parties of both branches of Congress.

Upon motion made and seconded, it was:

RESOLVED, That the next annual meeting of the Institute be held in New York City on May 7, 1932, and the following program was suggested: Council luncheon, 12 M.; Council Business meeting, 1:00 P. M.; Institute meeting, 3:00 P. M.; Dinner and Medal Award, 6:30 P. M.

The President appointed Mr. Neiman, Mr. Gordy, and Miss Kimball as a committee to cooperate with the President in the formulation of details for the Annual Meeting.

Upon motion made and seconded, it was:

RESOLVED, That the roster of the Institute be published separate from the regular issues of *The* CHEMIST, and that it be published immediately after the Annual Meeting.

Dr. Van Doren presented the recommendations of the Committee on Constitutional Revision, and after considerable discussion a number of amendments were suggested. The Secretary was directed to advise the members that the Council recommends the adoption of such amendments.

A motion was adopted thanking the Committee on Constitutional Revision for their excellent report. The Committee was continued with the request that they propose amendments to the By-laws.

A suggested form of pamphlet relative to The American Institute of Chemists was presented, and upon motion made and seconded, the editor of *The* CHEMIST was directed to have 1000 of such pamphlets printed at a cost of $27.50.

Dr. Crossley reported upon a reprint of the report of the Committee on Professional Education, which appeared in the June, 1931, issue of *The* CHEMIST, and upon motion made and seconded, the editor of *The* CHEMIST was directed to have 1000 of these printed at a cost of $35.00; and that a proof of said report be submitted to the Chemical Foundation, as it may desire additional copies for its purposes.

Dr. Knight resubmitted a former report of the Committee on Ethics, which had been discussed at the last meeting of the Council. During the absence of Dr. Knight and at his suggestion, the Secretary was directed to send a copy of this report to each member of the Council with a request that they comment thereon, or upon any other section of the present code of ethics, and that the matter be referred to the next meeting of the Council.

The Secretary reported upon the present membership.

There being no further business, adjournment was taken.

HOWARD S. NEIMAN, *Secretary*

New York Chapter

The February meeting of the Chapter was held on the evening of the fifth, at The Chemists' Club. Following the dinner Mr. Bethune G. Klugh, vice-President of Swann Chemical Company and vice-president of Swann Research, Inc., delivered a comprehensive address entitled, "The Chemist in the Fertilizer Industry." His thorough treatment of the subject, dealing with the problem of fertilization generally and with the contribution of chemical research in developing the most recent synthetic fertilizer involved, bespoke the broad experience of the speaker.

The question period brought out many interesting points of view. Among those who discussed the paper were H. O. Chute, J. F. X. Harold, Edward L. Gordy, Leon V. Quigley.

The meeting adjourned at 10:30 P. M.

LEON V. QUIGLEY, *Secretary*

Washington Chapter

A joint meeting of the Washington Chapter of The American Institute of Chemists and the Chemical Society of Washington (local chapter of the American Chemical Society) was held in the assembly hall of the Cosmos Club, preceded by a dinner to Dr. L. V. Redman.

Among the thirty-six who attended the dinner were: Henry G. Knight, Charles L. Parsons, Harrison E. Howe, Russell S. McBride, C. A. Browne, C. C. Concannon, J. N. Taylor, T. W. Delahanty, Warren E. Emley, William D. Appel, S. F. Acree, Raleigh Gilchrist, William R. Ross, J. F. Couch, H. T. Herrick, Albert R. Merz, M. X. Sullivan, and Colin M. Mackall.

The meeting was very successful, and the address presented to chemists a novel and interesting side of chemical research. The address will be reported at length in a later issue of *The* CHEMIST.

D. F. J. Lynch, *Chairman*

Philadelphia Chapter

The Chapter met at the Engineers' Club, Philadelphia, Tuesday, February 2nd. Owing to the presence of many visitors the business of the meeting was dispensed with and Chairman Franklin D. Jones introduced the speaker of the evening, Professor William Seifriz, of the Botany Department of the University of Pennsylvania, who spoke on the "Status of the Scientist in Russia."

Few people have traveled the entire width and length of Russia, but this great stretch of territory has been traversed by Professor Seifriz in the past three years as he gathered material for a series of articles on the distribution of plant life according to altitude. His travels have extended from the Crimea eastward to Chinese Turkestan, from the little republic of South Georgia northward to the Arctic Ocean, and have included such little-known regions as the Republic of Svanetia.

During these visits, Dr. Seifriz had ample opportunity to witness the working of the Five-Year Plan, and was particularly interested in the status of the scientist in Russia. No restrictions were placed upon him, nor were efforts made to have him view only certain selected show places. For only one afternoon during his entire trip was he accompanied by a guide. Many of the Russian scientists are his friends and colleagues, so that the sources of his information are authentic. Contrary to popular belief, Dr. Seifriz found that science in all its major branches is flourishing. The Soviet is greatly interested in research and is willing to spend huge sums of money for equipment. Many laboratories in the Universities and other scientific centers are splendidly equipped with the latest types of apparatus, and little effort is made to influence the nature of the work, except for occasional emphasis on practical problems though much fundamental and purely theoretical work is carried on. The investigators can be and often are violently anti-communistic in their beliefs, but if they take no active part against the government nothing is said or done to them.

Due to the active participation of government in all forms of industry, and the great burden imposed upon everyone in an effort to meet the requirements of the Five-Year Plan, there has been and still is, however, a considerable amount of petty interference in one's routine in life. Skilled scientists are frequently hauled off in a truck to pull

weeds, and there is generally little respect for one's time. It is hoped that this type of petty annoyance, and many other abuses of personal liberty will soon diminish.

Living conditions are still bad in many parts of Russia. The housing situation is critical in the large cities, and new clothes are almost unknown. No one need starve, but much precious time must be wasted in waiting for food. There is no longer equality of wages, the engineer and the scientist being among the highest paid. Only physicians are allowed to collect private fees, although anyone can obtain the services of a government physician free if he is willing to wait his turn.

On the whole, Dr. Seifriz seemed to feel that the only cause for unhappiness in Russia, the only reason for any serious interference with the freedom of the individual, was the stress of keeping up with the Five-Year Plan. If this plan had been spread over a longer time, say fifteen years, it could have been accomplished with much less interference in personal liberty and much more happiness for everyone.

Under the existing conditions, the Soviet government will spend millions for equipment for scientific laboratories, but will make no effort to heat them or make them otherwise comfortable places in which to work. A more rational attitude is slowly developing, however, and personal comfort and happiness are factors which are gradually being more and more appreciated. The scientist who writes a book or does a good piece of work of any kind is given an extra fee, and there are other evidences of a better understanding of human nature. But the tractor and the hydroelectric turbine are symbols of Soviet Russia, and the engineer its god. This is a far cry from the Russia of the czars and grand dukes.

The talk was very interesting and instructive and created considerable discussion, in which visitors as well as members participated.

This meeting was the largest the Chapter has had; and from the conversation at the dinner and later at the meeting, it was evident that chemists are much interested in international affairs.

The Chairman appointed a nominating committee to present names of prospective officers for the coming year.

BENJAMIN LEVITT, *Secretary*
HOWARD STOERTZ, *Reporter*

New Members

The following members were elected at a meeting of the National Council held on February 11th.

FELLOWS

FRANK GOTTLOB BREYER, Consulting Engineer, 420 Lexington Ave., New York, N. Y.

ELSA R. ORENT, National Research Fellow, Johns Hopkins University, Baltimore, Md.

ASSOCIATES

SAMUEL HAROLD CULTER, Chief Analyst, Burroughs Wellcome & Co., Tuckahoe, N. Y.

EMIL DAVIDSON, Sales Promotion and Chemical Adviser, Pfaltz and Bauer, 300 Pearl Street, New York, N. Y.

DR. KIRBY E. JACKSON was raised from the rank of Associate to that of Fellow.

NEWS

Edward C. Strube, formerly a member of the research staff of the General Cable Corporation, Rome, New York, is now in the Works Laboratory of the General Electric Company, Bridgeport, Conn.

John E. Bucher, formerly Head of the Department of Chemistry at Brown University, has become a member of the staff of College Research Institute, Yellow Springs, Ohio.

Medal to Conant

The Chandler Medal for achievement in chemical science was presented on February 5th to Professor James Bryant Conant, chairman of the division of chemistry at Harvard University.

The award was made to Dr. Conant for his work in organic chemistry, particularly the chemistry of chlorophyll.

One of the most brilliant of the younger chemists, Dr. Conant is known for his active mind and for his interesting and important research problems.

New Preservative

Aluminum Industries, Inc., has developed a preservative for metals, stone, wood, or fabric. The new material, called permite resalum, was developed from a synthetic resin which is heat resisting, non-corrosive, and weather proof.

The resin can be mixed with aluminum paint and sprayed on the surface in one operation.

Chemistry and Perfumes

The remarkable ramifications of the study of perfumes were discussed by Marston T. Bogert, F.A.I.C., professor of organic chemistry at Columbia, at the monthly Science Forum of the New

York Electrical Society, in a lecture on "Perfume Engineering."

The study of the connection between the physiological effect of odors as noted in living organisms, and their chemical molecular structure, Professor Bogert stated, presents far-reaching possibilities. The nature of life itself may be the outcome of this study originated in perfumes.

Dr. Bogert also discussed the possibility of using perfumes as anesthetics and in the boilers of industrial plants.

Joseph W. E. Harrison, consulting and research chemist, has been appointed lecturer in physiological assaying at the Philadelphia College of Pharmacy and Science.

Chemical Merger

The Official Testing Laboratory for twenty-seven years located at 191 Franklin Street, New York, has been merged with Foster D. Snell, Inc., Brooklyn firm of chemists and engineers. R. O. Brooks, former State Food Inspection Chemist of New Jersey and Pennsylvania and Director of the Official

STAFF OF FOSTER D. SNELL, INC.

Testing Laboratory since its founding in 1905, becomes a member of the technical staff of the Snell organization.

Foster D. Snell, Inc., already one of the largest firms of its kind in the United States, does not limit its industrial consulting and management service to food and drug chemistry. In his connection with the Snell organization, Mr. Brooks will continue to specialize in this field.

Postponement

The International Union of Chemistry announces that the proposed Ninth International Congress of Pure and Applied Chemistry, scheduled for Madrid beginning April 3rd, has been postponed because of the present world situation.

Francis P. Garvan has been made a Chevalier of the Legion of Honor, the decoration being presented by Ambassador Paul Claudel, following a dinner at the home of Mr. and Mrs. P. C. Cartier.

Lafayette B. Mendel, professor of physiological chemistry at Yale, was presented on his sixtieth birthday with a portrait of himself, painted by John Quincy Adams. Over 400 students and associates participated in making the gift in recognition of Professor Mendel's long and distinguished service as a teacher.

Dr. Mendel received the medal of The American Institute of Chemists in 1927.

Berkeley L. Hathorne and **Henry Green** have formed a consulting firm with offices at 114 East 32nd Street, New York, N. Y. Their specialty will be rayon, a chemical field in which they will continue to act as consultants for the Tubize Chatillon Corporation.

Meeting of Colorists

At a meeting of the Southeastern Division of the American Association of Textile Chemists and Colorists, the following officers were elected: treasurer, H. H. Field; vice-president, Rodney Fields, Jr.

A number of new members were elected to the association.

The American Society of Biological Chemists will meet in Philadelphia, April 28th to 30th.

The Electrochemical Society will meet at the Lord Baltimore Hotel, Baltimore, April 21st to 23rd.

Relief Committee

Organization of the Committee on Unemployment and Relief for Chemists and Chemical Engineers, sponsored by the chemical and allied societies of the New York metropolitan area, has been completed and the committee is now operating in the attempt to find work and assistance for the unemployed members of the profession. Employment has been found for a number of men.

Either funds or access to jobs are urgently required by the committee. There are extremely few jobs open in the chemical industries, and there are almost daily reports of additional chemists being laid off. In order for the committee to be able to secure funds or jobs from those able to assist, it is essential that actual figures be available as to the number unemployed and in need. The committee is already in a position to furnish well qualified men in many different lines. Employed chemists and employers can assist by reporting promptly to the committee any vacancies or the names of any firms that might be in a position to use men. Work along chemical lines is of course preferred. However, jobs of any kind will be welcome.

There are no charges of any kind for this service. The office at 50 E. 41st St. (downstairs) is open week days from 10–12 and 2:30–5. Unemployed are urged to register now.

Charles H. McDowell has resigned as president of Armour Fertilizer Works and vice-president of Armour and Company. He will continue to serve as a director of the latter firm.

H. H. Sheldon, physicist and engineer has been elected president of The American Institute of the City of New York. The other officers elected were Otis W. Caldwell, vice-president; William Crocker, secretary; Alfred Knight, treasurer.

The American Institute, which is the oldest scientific society in New York State, was founded in 1828 and has been continuously active during the 104 years of its existence.

At present, The American Institute is especially interested in acquainting the public with the achievements of modern scientific research. Its activities include the holding of the Children's Science Fair and various scientific meetings and round table discussions.

Dr. Sheldon, the new president of the Institute, is Professor and Chairman, Department of Physics, Washington Square College, New York University. He is well known as a writer, being the author of *An Outline of Science, Time and Relativity, Television,* and numerous scientific articles. He is also known as a speaker.

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